BFED Committee

From: Shaun Ortega <shaun.ortega@jci.com>
Sent: Tuesday, November 25, 2025 3:58 PM
To: Cynthia D. Lallo
Cc: BFED Committee; emily.e.bartow@co.maui.hi.us; lesley.j.milner@co.maui.hi.us; Lowen Okamoto; Leif Kjonegaard
Subject: Maui County Phase 1 – Year 1 M&V Report
Attachments: JCI Maui Ph1 Y1 MV Report.pdf; Appendix A - FIM 4 - Power Measurements - Maui Co-Phase 1 Powersmiths Transformer MV Report Ver1.pdf

Aloha Cynthia,

I am an Energy Performance Engineer with Johnson Controls and will be overseeing the Energy Savings Performance Contract for Maui County Phase 1. My responsibilities include conducting Measurement and Verification (M&V) for your systems.

Attached is the Maui County Phase 1 Year 1 M&V Report for your review. This report summarizes your energy savings during the Year 1 performance period. Once accepted, please sign page 2 of the report and email it back to me.

I've also included Appendix A. However, I was unable to attach Appendix B – FIM 9 – BES Closeout – Maui County Ph. 1 due to its size (26.4 MB). Do you have a SharePoint link we can use to upload all the documents? Alternatively, if you prefer, we can print all the documents and deliver a hard copy to you. Please let us know which option works best.

If you have any questions or need clarification, please don't hesitate to reach out—I'll be happy to discuss further.

Have a Happy Thanksgiving!

Mahalo,

Shaun Ortega

Sustainable Infrastructure
Johnson Controls

+1 808 284 2799 work cell
+1 808 500 3468 personal cell

The power behind **your mission**

COUNTY OF MAUI
STATE OF HAWAII

Measurement and Verification
Year 1 Report

ENERGY SAVINGS
PERFORMANCE CONTRACT:
NO. C7619

November 2025

Executive Branch Office
County of Maui

November 25, 2025

Office of the Mayor
c/o Cynthia Lallo, Chief of Staff
Executive Branch Office
Kalana O Maui Building
200 South High Street
Wailuku, Maui, HI 96793

Dear Ms. Cynthia Lallo, Chief of Staff at the Office of the Mayor

Please find attached the Year 1 Annual Savings Report for the Energy Savings Performance Contract (ESPC) Report for Maui County Phase 1 Performance Contract. Pursuant to the contract signed September 2022, Johnson Control commenced construction immediately thereafter and started to realize energy savings. Year One started October 1, 2024, through September 30, 2025, the total cost savings amounted to $1,646,163; exceeding the guaranteed savings of $1,570,928 by $638,635.

In the following report includes a summary of measured data with respect to the Facility Improvement Measures (FIMs) verified during the Year 1 period. This effort serves as supporting documentation for energy savings for the reporting period.

Following review and acceptance of this Report please return a signed copy of this letter to:

Johnson Controls
Attn: Shaun Ortega
550 Paiea St #210
Honolulu, HI 96819
(808) 284-2799

ACCEPTANCE

The Post Installation Report for the Energy Savings Performance Contract is accepted by the undersigned.

Signature: ________________________________ Date: __________________________

Title: ____________________________________

Sincerely,

Shaun Ortega
Energy Performance Engineer
shaun.ortega@jci.com

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Executive Summary

Maui County and Johnson Controls (JCI) entered a contract amendment No. C7169 on September 28, 2022, to implement a set of Facility Improvement Measures (FIMs) to reduce energy (electricity, water, and natural gas) usage, demand, and utility cost across all County of Maui Departments.

This report presents the results and impact of the Performance Contract from October 1, 2024 to September 30, 2025. The work defined in the Performance Contract, scope of work, was performed at multiple buildings across the county are provided in this report.

- Installation Period: October 1, 2022 to September 30, 2024
- Total Installation Period Achieved Savings: $637,717
- Performance Period: October 1, 2024 to September 30, 2025
- Measured Performance Period Utility Cost Avoidance: $1,396,769
- Total Performance Period Achieved Savings: $1,646,163
- Guaranteed Performance Period Savings: $1,570,926
- Performance Period Excess Savings (exceeded guaranteed by): $638,635
- Total Performance Period Electric Consumption Avoidance: 2,409,666 kWh
- Total Performance Period Electric Demand Avoidance: 647 kW
- Total Performance Period Water/Sewer Avoidance: 91,865 kGal

Background

Revised Investment Grade Audit

Maui County and Johnson Controls entered a revision to the contract on November 19, 2024, and substantially reduced or entirely removed the following FIMs: FIM 2: Exterior LED Lighting Retrofits and FIM 7: Irrigation Wells.

The FIMs included in this project continue to focus on optimizing energy efficiency and sustainability. The FIMs are listed below and will be discussed in detail in the remainder of this document:

FIM #	FIM Description
1	Interior LED Lighting Retrofits
4	Transformer Replacements
5	Domestic Water Plumbing Fixture Upgrades
6	Shower Tower Retrofits
7	Irrigation Wells Systems
8	On-Site Hypochlorite Generation & Smart Pool Pump Controls
9	Infiltration Reduction
10	Window Film

Guaranteed and Verified Savings

This report outlines the energy savings achieved by the county during Year 1 and installation period of the project. The guaranteed savings for this period amount to $1,570,928. Utility cost savings total $1,395,567, resulting in overall cost savings of $2,284,798. A detailed breakdown is presented in Table 1.

Table 1: Year 1 Period Cost Savings Summary

	Electric Savings (kWh)	Electric Cost Savings ($)	Electric Demand Savings (kW)	Demand Savings ($)	Water + Sewer Savings (kGal)	Water + Sewer Savings ($)	O&M Savings ($)	Total Cost Savings ($)
Proposed Original IGA	2,893,887	$1,188,548	598	$131,728	177,461	$828,746	$274,247	$2,423,269
Revised IGA	**2,508,132**	**$971,058**	**597**	**$47,953**	**87,293**	**$301,400**	**$250,516**	**$1,570,928**
Verified Year 1	**2,415,632**	**$962,243**	**647**	**$45,624**	**85,829**	**$337,663**	**$250,596**	**$1,646,163**
Variance	**(98,466)**	**$11,678**	**50**	**($2,329)**	**4,571**	**$65,806**	**$80**	**$75,235**
							Construction Period Savings	**$637,717**
							Year 1 Combined Savings	**$2,283,880**

Per revised investment grade audit document, the cost savings were escalated using the following table presented below.

Table 1.5: Year 1 Escalation Rates

Cost Type	Escalation Rates	Notes
Electric	5%	Rate Escalation started at Installation.
Water/Sewer	1%	Rate Escalation started at Installation.
O&M	5%	Rate Escalation for O&M starts at Year 1.

Proposed Year 1 savings total $1,570,928, driven by 2,508,132 kWh of electric savings, 597 kW of demand reduction, 87,293 kGal of water savings, and $250,516 in O&M savings. Interior lighting, pool pumps, and shower towers are the top contributors.

Table 2: Year 1 Annual Guarantee by FIM per Revised IGA

FIM	FIM Description	Electric Savings (kWh)	Electric Cost Savings ($)	Electric Demand (kW)	Demand Savings ($)	Water + Sewer Savings (kGal)	Water + Sewer Savings ($)	O&M Savings ($)	Total Cost Savings ($)
1	**Lighting Group**	0	$0	0	$0	0	0	$0	$0
1A	Interior Lighting Retrofit	1,306,406	$507,862	383	$42,432	0	0	$0	$550,293
1B	Lighting O&M	0	$0	0	$0	0	0	$21,091	$21,091
4	**Transformer Replacements**	159,315	$57,280	214	$5,522	0	0	$0	$62,802
5	**Domestic Water Plumbing Group**	0	$0	0	$0	0	0	$0	$0
5A	Domestic Water Plumbing	0	$0	0	$0	22,570	$96,824	$0	$96,825
5B	Domestic Hot Water - Non-measured	34,003	$13,665	0	$0	0	0	$0	$13,665
6	**Shower Towers**	0	$0	0	$0	54,005	$150,224	$0	$150,224
7	**Irrigation Wells**	0	$0	0	$0	1,663	$10,026	$0	$10,026
8	**On-Site Hypochlorite Generation Group**	0	$0	0	$0	0	0	$0	$0
8A	Pool Pumps	808,150	$314,243	0	$0	0	0	$0	$314,243
8B	Pools O&M - Chemicals	-94,692	($37,138)	0	$0	9,055	$44,325	$229,425	$236,613
9	**Building Envelope**	275,883	$107,594	0	$0	0	0	$0	$107,594
10	**Window Film**	19,067	$7,552	0	$0	0	0	$0	$7,552
Total Savings		**2,508,132**	**$971,058**	**596.98**	**$47,953**	**87,293**	**$301,400**	**$250,516**	**$1,570,928**

The table below demonstrates Year 1 verified savings totaled $1,646,163, driven primarily by lighting retrofits and water conservation measures. Combined electric savings were 2,409,666 kWh, water savings reached 91,865 kGal, and demand reductions totaled 647 kW, confirming strong performance across implemented Facility Improvement Measures (FIMs).

Table 3: Year 1 Verified Savings by FIM

FIM	FIM Description	Electric Savings (kWh)	Electric Cost Savings ($)	Electric Demand (kW)	Demand Savings ($)	Water + Sewer Savings (kGal)	Water + Sewer Savings ($)	O&M Savings ($)	Verified Year 1 Cost Savings ($)
1	**LIGHTING GROUP**								
1A	Interior Lighting Retrofit	1,336,194	$ 548,121	345	$ 38,235				$ 586,356
1B	Lighting O&M							$ 21,171	$ 21,171
4	**Transformer Replacements**	219,896	$ 78,994	301	$ 7,389				$ 86,383
5	**DOMESTIC WATER PLUMBING GROUP**								
5A	Domestic Water Plumbing					26,070	$ 104,314		$ 104,314
5B	Domestic Hot Water - Non-measured	45,822	$ 18,110						$ 18,110
6	**Shower Towers**					57,928	$ 222,497		$ 222,497
7	**Irrigation Wells**					1,663	$ 10,026		$ 10,026
8	**ON-SITE HYPOCHLORITE GENERATION GROUP**								
8A	Pool Pumps	553,684	$ 241,230						$ 241,230
8B	Pools Chemicals	(64,876)	$ (28,509)			6,204	$ 30,369	$ 229,425	$ 231,285
9	**Building Envelope**	293,624	$ 114,681						$ 114,681
10	**Window Film**	25,321	$ 10,111						$ 10,111
	YEAR 1 TOTAL SAVINGS	**2,409,666**	**$ 982,737**	**647**	**$ 45,624**	**91,865**	**$ 367,206**	**$ 250,596**	**$ 1,646,163**

The table compares proposed and verified savings for each FIM across four categories: electric cost, demand, water and sewer, and operations and maintenance (O&M). Verified savings surpassed proposed values in most categories, demonstrating effective implementation and accurate performance tracking. Overall, the project is achieving 4.8% higher total savings than projected. Water conservation measures significantly outperformed expectations, while energy savings closely matched projections.

Table 3.1: Year 1 - Verified Vs. Expected Annual Cost Savings by FIM

FIM	FIM Description	Electric Cost Savings ($)		Demand Savings ($)		Water + Sewer Savings ($)		O&M Savings ($)		Year 1 Cost Savings ($)	
		Proposed	Verified	Proposed	Verified	Proposed	Verified	Proposed	Verified	Estimated	Verified
1	**LIGHTING**										
1A	Interior Lighting Retrofit	$507,862	$548,121	$42,432	$38,235					$550,293	$586,356
1B	Lighting O&M							$21,091	$21,171	$21,091	$21,171
4	**Transformer Replacements**	$57,280	$78,994	$5,522	$7,389					$62,802	$86,383
5	**Domestic Water Plumbing**										
5A	Domestic Water Plumbing					$96,825	$104,314			$96,825	$104,314
5B	Domestic Hot Water - Non-measured	$13,665	$18,110							$13,665	$18,110
6	**Shower Towers**					$150,224	$222,497			$150,224	$222,497
7	**Irrigation Wells**					$10,026	$10,026			$10,026	$10,026
8	**ON-SITE HYPOCHLORITE GENERATION**										
8A	Pool Pumps	$314,243	$241,230							$314,243	$241,230
8B	Pools - Chemicals	-$37,138	-$28,509			$44,326	$30,369	$229,425	$229,425	$236,613	$231,285
9	**Building Envelope**	$107,594	$114,681							$107,594	$114,681
10	**Window Film**	$7,552	$10,111							$7,552	$10,111
	Year 1 Total Savings	**$971,058**	**$982,737**	**$47,953**	**$45,624**	**$301,400**	**$367,206**	**$250,516**	**$250,596**	**$1,570,928**	**$1,646,163**

Rebates

No additional rebates are applicable during the performance period.

Johnson Controls applied for rebates during the construction period for two FIMS for this project: interior lighting retrofit and Transformers.

For Lighting, as of February 2025, Johnson Controls has so far submitted the rebate application, on behalf of the County Maui, for the amount of $10,399 under LED Fixtures, and additional 30 rebate applications are being prepared for submission.

For Transformers, Johnson Controls has so far submitted the rebate application for the amount of $36,505.10, and the rebate checks were mailed out from 2023 through 2024.

Measurement & Verification

Overview

The following is a brief overview of the measurement and verification methodologies applicable to the Improvement Measures set forth below. Johnson Controls shall apply these methodologies, as more fully detailed in the guidelines and standards of the International Measurement and Verification Protocol (IPMVP), in connection with the provision of M&V Services.

Option A: Retrofit Isolation: Key Parameter Measurement

Key Parameter Measurement savings are determined by field measurement of the key performance parameter(s) which define the energy use of the FIM's affected system(s) as part of the project. Measurement frequency ranges from short-term to continuous, depending on the expected variations in the measured parameter, and the length of the reporting period. Parameters not selected for field measurement are estimated. Estimates can based on historical data, manufacturer's specifications, or engineering judgment. Estimations will be shown in the M&V plan. Engineering calculations using measurements and estimates are used to calculate Measured Project Benefits for the duration of the Guarantee Term.

OV Approach: Operational Verification

Verification that the FIMs are installed and operating properly and have the potential to generate savings. No field measurements are required.

Table 4 lists each FIM, and corresponding M&V Option utilized for this program.

Table 4: Summary of M&V Options

FIM#	FIM Description	M&V Option	Report Frequency
1	**Lighting Group**		Post Installation
1A	*Interior Lighting Retrofit*	A – One time	
1B	*Lighting O&M*	Non-measured	
4	**Transformer Replacements**	A – One time	Post Installation
5	**Domestic Water Plumbing Group**		Post Installation
5A	*Domestic Water Plumbing*	A – One time	
5B	*Domestic Hot Water - Non-measured*	Non-measured	
6	**Shower Towers**	A – One time	Post Installation
7	**Irrigation Systems**	OV* – One time	Post Installation
8	**Hypochlorite Generation and Smart Pool Pump Controls**	OV* – One time	Annually
8A	*Smart Pool Pump Controls*	A – Quarterly	
8B	*Pools O&M - Chemicals*	Non-measured	
9	**Infiltration Reduction**	OV* – One time	Post Installation
10	**Window Film**	A – One time	Post Installation

*OV – Operation Verification

FIM 1: Interior LED Lighting Retrofits

FIM Description

Lighting energy efficiency upgrades provide a substantial energy benefit along with potential quality of light improvements. Facility owners realize significant operating utility savings, reduced maintenance costs, and improved overall lighting systems performance.

The existing lighting systems across Maui County consists of a wide variety of lighting technologies. The proposed solutions will result in improved efficiency. Effort has been made to standardize the installed components to reduce operational and maintenance costs over the life of the installed system. Johnson Controls provided an attic stock of materials and as described in the planned maintenance section provide maintenance services for the lighting scope of work. A detailed scope of work description is included in the Appendix 1-Interior Lighting Retrofits Scope of Work of the Post-Installation report.

Energy Savings Calculation Methodology

Lighting Retrofits Energy Savings

There are savings specifically associated with the reduction in wattage due to the lighting retrofits. The equations used are shown below:

Equations for Calculating Lighting Retrofit Savings

Demand (kW)

$\text{Connected kW Savings} = \sum_u [\,(\text{kW/Fixture}_{baseline} \times \text{Quantity}_{baseline} - \text{kW/Fixture}_{post} \times \text{Quantity}_{post})]_{t,u}$

$\text{Actual kW Savings} = \sum_u [\,\text{Connected kW Savings}_u \times \text{Coincident Factor}_u]_{t,u}$

where:

kW/fixturebaseline =	*lighting baseline demand per fixture for usage group u*
kW/fixturepost =	*lighting demand per fixture during post-installation period for usage group*
Quantitybaseline =	*quantity of affected fixtures before the lighting retrofit for usage group u*
Quantitypost =	*quantity of affected fixtures after the lighting retrofit for usage group u*
Coincident Factor =	*Coincident Factor is a percentage multiplier to account for Demand Diversity of each specific usage group u..*

Annual demand cost savings are determined by multiplying the kW demand savings by the corresponding facility demand rate ($/kW) times 12 months.

Energy (kWh)

$\text{kWh Savings}_{Lighting} = \sum_u [\,\text{Connected kW Savings}_u \times \text{Burn Hours}]_{t,u}$

where:

Connected kW Savings$_u$ =	total connected fixture demand reduction for usage group *u*
Burn Hours =	number of operating hours during the time period *t* for the usage group *u*

Annual energy cost savings are determined by multiplying the kWh energy savings by the corresponding facility energy rate ($/kWh).

Lighting Controls Energy Savings

There are savings specifically associated with the reduction in lighting burn hours due to the lighting controls (occupancy sensors and/or daylighting controls) installed as part of the lighting retrofits.

The lighting system annual burn hours pre and post-retrofit vary by space type as shown below. Pre-retrofit burn hours were estimated by JCI. The percentage reduction in burn hours and the resulting post-retrofit burn hours as a result of lighting controls (occupancy sensors and/or daylight controls) are estimated when comparing various energy groups and sources, such as: Illuminating Engineering Society (VonNieda B, Maniccia D, & Tweed A. 2000. An analysis of the energy and cost savings potential of occupancy sensors for commercial lighting systems. Proceedings of the Illuminating Engineering Society Paper #43), which estimates a range of 25% to 60% savings can be achieved with occupancy sensors. JCI assumed a 30% reduction in burn hours to be derived from installation of occupancy sensors, where included.

Equations for Calculating Lighting Controls Savings

Energy (kWh)

$$\text{kWh Savings}_{Lighting\ controls} = \sum_u \left[\text{kW Post}_u \times (\text{Pre-Hours of Operation} - \text{Post-Hours of Operation}) \right]_{t,u}$$

where:	*kW Post$_u$* =	kilowatt used during the post-installation time for usage group *u (will be equal to pre wattage if no fixture change)*
Pre-Hours of Operation =		number of operating hours during the baseline time period *t* for the usage group *u*
Post-Hours of Operation =		reduction in run time due to lighting controls

Annual energy cost savings are determined by multiplying the kWh energy savings by the corresponding facility energy rate ($/kWh).

Energy savings resulting from lighting controls are not cost effective to measure and verify, thus with the methodology described above, the Customer agrees that the savings generated through this reduction in lighting burn hours will be achieved. The lighting wattages were measured by JCI.

These savings will not be measured, and a table showing the total lighting controls savings is outlined in the Investment Grade Audit (IGA) document.

Operation and Maintenance (O&M) Cost Savings Calculations

Operation and Maintenance Cost avoidance achieved by reduced lighting material replacement resulting from installation of longer life LED technology. This is calculated on a room-by-room basis according to the run time of the room space and the service life of the LED retrofit proposed compared to the existing lighting technology installed.

For calculating materials savings, the cost and manufacturer's lifetime of each lamp, and LED in the project is used and averaged over the contract term. The average lamp life for different types of lamps are shown below:

Table 3.2: Lighting Fixture Information

Lamp	Lamp Wattage or Type	Average Lamp Life (Hrs)
Incandescent	100W	5,000
	150W	750
	40W / 50W / 60W	1,500
	65W	1,125
HID	1000W MH	12,000
	100W MH	20,000
	150W MH	15,000
	175W MH / 250W MH	10,000
	400W MH	20,000
	70W HPS	24,000
T8 Fluorescent	4' 25W	32,000
	4' 32W / 2' 17W	24,000
	3' 25W	36,000
	8' 59W	15,000
T12 Fluorescent	2' 20W	10,000
	3' 30W	18,000
	4' 34W	20,000
	60W	12,000
LED lamps	PAR20/ PAR38/ MR16/ screw in	25,000
	Retrofit plug in	30,000
	Tube / Pin-based lamps / HID replacement lamps / recessed can kits / canopy	50,000
	Wall pack	75,000
	Flood / area light / high bay	100,000

The following are the formulas used to quantify the O&M Savings:

Lamp Unit Cost per Hour = Average Lamp Cost ÷ Average Lamp Life.

Ballast Unit Cost per Hour = Average Ballast Cost ÷ Average Ballast Life.

Existing Annual Lamp Material Cost = Existing Burn Hours × Quantity of Lamps × Lamp Unit Cost per Hour.

Existing Annual Ballast Material Cost = Existing Burn Hours × Quantity of Ballasts × Ballast Unit Cost per Hour.

Proposed Annual Lamp Material Cost = Existing Burn Hours × Quantity of Lamps × Lamp Unit Cost per Hour.

Proposed Annual Ballast Material Cost = Existing Burn Hours × Quantity of Ballasts × Ballast Unit Cost per Hour.

Proposed Annual Material Cost = Proposed Burn Hours × ((Quantity of Lamps × Lamp Unit Cost per Hour) + (Quantity of Ballasts × Ballast Unit Cost per Hour)).

Annualized Project Term Material Savings = ((Project Term × (Existing Annual Lamp Material Cost + Existing Annual Ballast Material Cost)) - ((Project Term - Proposed Lamp Warranty Period) × Proposed Annual Lamp Material Cost) + ((Project Term - Proposed Ballast Warranty Period) × Proposed Annual Ballast Material Cost))) ÷ Project Term.

The lighting material savings calculation was performed on the entire inventory of lighting fixtures.

Applying both the current cost and expected useful life, operational cost savings (material only) are calculated, and the results are shown in the IGA document.

Operational cost avoidance material savings are non-measured and will be considered as being achieved upon the County acceptance of the completed project. No labor savings have been calculated or included herein.

Measurement and Verification

The savings for the lighting retrofit part of this FIM were verified using IPMVP-2016 Option A, Retrofit Isolation with Key Parameter Measurement. The savings for this FIM are generated through a reduction in energy used by the lighting system; therefore, the measurement boundary is the lighting system itself.

Key Parameter	Measurement Frequency	Measurement Description
Pre-Retrofit Fixture Power Draw (kW)	See *Energy Savings Calculations* section in the *FIM Descriptions*	The pre-retrofit power draw has been determined based upon measurements taken between 7/25/22 and 8/5/22 on a sample of fixtures that meet a confidence level of at least 80% and a precision of 20%– assuming a coefficient of variance of 0.5 – using a true RMS meter. These values will not be measured again.
Post-Retrofit Fixture Power Draw (kW)	One-time	The post-retrofit power draw on a sample of fixtures that meet a confidence level of at least 80% and a precision of 20%– assuming a coefficient of variance of 0.5 – will be measured using a true RMS meter. Fixtures with similar lamps and ballasts, counts and types will be grouped together with a lamp/ballast code. Measured wattages will be used when possible. In some situations, such as when a certain type of lighting fixture is not available by itself on a switch, typical wattages as published by ANSI (American National Standards Institute) will be used. The savings will be updated.
Estimated Parameters	**Assumed Value**	**Justification, Source and Description**
Burn Hours	See *Energy Savings Calculations* section in the *FIM Descriptions*	The lighting system annual run hours by space type are agreed upon. These run hours are based on historical data from industry sources or from customer feedback. These values will not be measured.
Coincident Factor	See *Energy Savings Calculations* section in the *FIM Descriptions*	The coincident factor is estimated based on the number of fixtures in a space type expected to be operating at the same time during the on peak period and is agreed to remain at the same value after the retrofit. This estimate is based on industry standards.

Performance Verification

This FIM is part of a one-time evaluation during the installation period; therefore, no M&V activities were conducted during Year 1 performance period. Below is a summary of the post-installation M&V activities that were conducted during installation. Johnson Controls checked and verified proper installation and operation of the new lighting systems after system startup and report findings to the customer. Johnson Controls provided lighting system startup according to manufacturer's recommendations. Johnson Controls measured the pre-installation and post-installation wattages of a sample fixture of each retrofit, according to required quantities based on an 80% confidence level at 20% precision. Per M&V plan, fixture wattages were measured using calibrated meters, but it did not result in significant changes to the savings.

Table 3.3: Lighting Pre-Measurements Summary

Usage Group	Population Size	Samples	Rated Watts	Measured Watts	Variance %
2X25T8EBN	315	5	40	37.84	5%
1X32T8EBN	136	7	31	28.17	9%
3X32T8EBN	272	6	89	85.98	3%
2X34T12MB	363	5	72	66.15	8%
2X18T8U6LEDT	18	2	36	32.38	10%
1X400MH	99	3	458	440.02	4%

Usage Group	Population Size	Samples	Rated Watts	Measured Watts	Variance %
1X34T12MB	80	3	43	36.93	14%
4X32T8EBN	500	7	112	106.40	5%
2X32T8U6EBN	95	5	59	55.62	6%
2X32T8EBN	3,332	7	58	55.43	4%
3X32T8EBN2	32	6	90	81.20	10%
1X250MH	49	3	295	311.97	-6%
1X70HPS	195	4	95	86.35	9%
1X150HPS	173	10	188	170.29	9%
1X250HPS	39	6	295	269.36	9%
1X1000MH	11	12	1,080	1020.09	6%
1X1500MH	56	5	1,610	1511.47	6%
Total	**5,765**	**96**	**95.99***	**90.89 ***	**5%**

*Weighted Average

Table 3.3: Lighting Post-Measurements Summary

Usage Group	Population Size	Samples	Rated Watts	Measured Watts	Variance %
2X4LED-DK-HS	1,037	17	18	16.30	9%
2X4LED-DK-HS4L	563	7	24	24.83	-3%
2X4LED-DK-HS3L	568	8	21	20.03	5%
1X4LED-DK	1,621	17	24	15.51	35%
1X4LEDF-W2L	926	17	21	19.16	9%
2X4FTLEDTYPEB	1,368	7	21	20.30	3%
1X4LEDF-VP	479	5	29	34.75	-20%
1X8LEDF-S-H	177	6	56	53.76	4%
2X2LED-DK-HS	239	9	18	16.00	11%
1X4LEDF-W-H4L	108	6	27	26.18	3%
1XLEDF-6RC	202	15	13	10.12	22%
2X4LED-DK-H	75	4	30	27.42	9%
2X2LED-DKS	84	5	12	12.01	0%
2X2LED-DK	4	5	20	21.10	-6%
1X4LEDF-SS	170	5	26	19.10	28%
4X4FTLEDTYPEB	152	2	42	36.89	12%
1X9LEDSI	101	6	9	8.46	6%
2X9LEDSI	30	6	18	16.32	9%
Total	**7,904**	**147**	**22.83***	**20.39***	**11%**

*Weighted Average

Table 3.5: Energy Saving Analysis Summary

	Audit Qty	Proposed Qty	kW Saved	kWh Saved/Yr
Sold Total	11,902	11,902	386	1,452,364
As-Built Total	12,043	12,043	322	1,262,986

Additional Site Savings Total	392	392	23	73,208
Delta	533	533	(41)	(116,170)

Verified Savings

Energy Savings for lighting improvement change moderately by 29,788 kWh and $36,142 surplus savings from the revised scope of work as documented in the revised Investment Grade Audit. There were de-scoped fixtures, as well as added scope as part of the revised IGA. Below is summary of changes and cost savings impact. The cost savings were updated to reflect Year 1 rates. Detailed line by line spreadsheet documentation is electronically attached to the report as an appendix A of the post installation report.

Table 3.3: Lighting Savings Summary

	Electric Savings (kWh)	Electric Cost Savings ($)	Electric Demand (kW)	Demand Savings ($)	O&M Savings ($)	Total Proposed Cost Savings ($)
Proposed Original IGA	**1,426,014**	**$ 549,746**	**378**	**$ 69,566**	**$ 21,449**	**$ 640,761**
Revised IGA	**1,306,406**	**$ 507,862**	**383**	**$ 42,432**	**$ 21,091**	**$ 571,384**
Verified Year 1	**1,336,194**	**$ 548,121**	**345**	**$ 38,235**	**$ 21,171**	**$ 607,527**
Variance (Verified Year 1 - Revised IGA)	**29,788**	**$ 40,259**	**(38)**	**$ (4,196)**	**$ 80**	**$ 36,142**

FIM 4: Transformer Replacements

FIM Description

The proposed solution is to replace the existing dry type building distribution transformers (like for like nominal kVA capacity) with DOE-2016 efficiency transformers of the same configuration (i.e. 3-phase, delta-wye). No transformers will be relocated, resized, nor will changes be made to the building electrical design. By replacing the old transformers with new transformers, the same amount of electricity can be delivered to the building with lower losses thereby reducing overall energy costs.

The existing dry-type transformers will be removed and replaced with Powersmiths E-Saver ultra-low loss, dry-type transformers, or equivalent. The retrofit transformer will minimize installation cost by taking into account existing site conditions such as transformer footprint and pad dimensions, clearances to walls and other adjacent equipment, conduit entry points, and access (delivery to and from dock). While replacement transformers will not be exact dimensional matches for existing transformers, design of the replacement transformers will minimize installation conflicts and the need to splice conductors or add conduit.

Transformers that were surveyed that were newer (high efficiency), had code issues as discussed above, and/or had no direct/easy replacement (because of configuration or dimensions), will not be replaced.

The following table shows the quantities and sizes of the dry-type transformers that are good candidates for replacements, and are included in JCI's Scope of Work:

Site	Transformer size (kVA)												Total Qty
	14	15	25	30	37.5	45	50	63	75	112.5	150	225	
Kahului Baseyard						1			1				2
Kahului Pump Station				1									1
Kahului WRF		1	1	1		2	1						6
Kalana O Maui						1							1
Kihei Police Station		1										1	2
Kihei WRF				1	1	2			3	1	1		9
Lahaina WRF		1				2			1				4
Lahaina-1 Pump Station									1				1
Lahainaluna WTP									1				1
Mahinahina WTP	1				3								4
Olinda WTP				2									2
Piiholo WTP						2							2
Wailuku Police Station				2		6			1				9
War Memorial									1				1
Grand Total	**1**	**3**	**1**	**7**	**4**	**16**	**1**	**0**	**9**	**1**	**1**	**1**	**45**

Energy Savings Calculations Methodology

Transformer Retrofits Energy Savings

There are savings specifically associated with the reduction in wattage due to the transformer replacements. The equations used are shown below:

Equations for Calculating Transformer Retrofit Savings

The annual kWh savings will be calculated according to the following formulas:

$$Xmr\ Losses\ Normal\ kW = (No\ Load\ loss\ kW\ \ +\%Load\ Normal^2\ x\ (Full\ Load\ Loss\ kW - No\ Load\ Loss\ kW)$$

$$Xmr\ Losses\ Out\ kW = (No\ Load\ loss\ kW\ \ +\%Load\ Out^2\ x\ (Full\ Load\ Loss\ kW - No\ Load\ Loss\ kW)$$

kWh normal savings = [Xmr Losses Normal $kW_{(pre)}$ – Xmr Losses Normal $kW_{(post)}$] x Daily Hours of Operation x Days of Operation per Year

kWh out savings = [Xmr Losses Out $kW_{(pre)}$ – Xmr Losses Out $kW_{(post)}$] x (24 - Daily Hours of Operation) x Days of Operation per Year

Total kWh savings = kWh normal savings + kWh out savings

Where:

% Load Normal:	Typical % Load on transformer during normal operating hours (See Transformer Loading Table below)
% Load Out:	Typical % Load on transformer outside of normal operating hours (See Transformer Loading Table below)
Full Load Loss:	Full load losses on transformer (see Load Losses Table below)
No Load Loss:	No load losses on transformer (see Load Losses Table below)
Xmr losses Normal kW:	Transformer kW losses during Normal Operation hours
Xmr losses Out kW:	Transformer kW losses outside of Normal Operation hours
Daily Hrs Operation:	Estimated normal daily hours of operation; this variable will not be measured (see Operating Hours Table below).
Days of Operation:	Estimated days of operation per year; this variable will not be measured (see Operating Hours Table below).

Annual energy cost savings are determined by multiplying the kWh energy savings by the corresponding facility energy rate ($/kWh).

Measurement and Verification

The savings for this FIM were verified using IPMVP-2016 Option A, Retrofit Isolation with Key Parameter Measurement. The savings for this FIM are generated through a gain in efficiency in the new equipment compared to the existing equipment; therefore, the measurement boundary is the transformer itself.

Key Parameter	Measurement Frequency	Measurement Description
Baseline Transformer Input Losses	Short-Term	Transformer input losses (kW) is measured typically for a duration of 15 min of each transformer measured.
Baseline Transformer % Load	Short-Term	Transformer % Load is measured typically for a duration of 15 min of each transformer measured.
Post Installation Transformer Input Power	Short-Term	Line side power will be measured via a third-party certified test lab modeled to match pre-retrofit test (measurement) conditions
Post Installation Transformer Output Power	Short-Term	Load side power will be measured via a third-party certified test lab modeled to match pre-retrofit test (measurement) conditions
Estimated Parameters	**Assumed Value**	**Justification, Source and Description**
kVA	See *Scope of Work* section in the *FIM Descriptions*	Transformer rating, assumed to be the same pre and post.
Hours & Days of Operation	See *Energy Savings Calculations* section in the *FIM Descriptions*	Assumed to be derived from data collected during audit.

Performance Verification

This FIM is part of a one-time evaluation during the installation period; therefore, no M&V activities were conducted during Year 1 performance period. Field measurements were taken during construction and can be found in Appendix A – FIM 4 – Power Measurements.

Verified Savings

Energy savings for FIM 4, Transformers, resulted in an additional $23,581 saved. Johnson Controls used a conservative method to estimate energy savings for this FIM, and according to factory test data, the actual performance exceeded the initial projections. The cost savings were updated to reflect Year 1 rates.

Detail list of transformers and savings calculation is attached as Appendix B of the post installation report, electronically.

Table 4.1: Transformer Savings Summary

	Electric Savings (kWh)	Electric Cost Savings ($)	Electric Demand (kW)	Demand Savings ($)	Total Proposed Cost Savings ($)
Proposed Original IGA	160,512	$ 57,971	220	$ 62,163	$ 120,134
Revised IGA	159,315	$ 57,280	214	$ 5,522	$ 62,802
Verified Year 1	219,896	$ 78,994	301	$ 7,389	$ 86,383
Variance (Verified Year 1 - Revised IGA)	60,581	$ 21,713	87	$ 1,867	$ 23,581

FIM 5: Domestic Water Plumbing Fixture Upgrades

FIM Description

This measure entails the replacement of existing high-volume plumbing fixtures—including toilets, urinals, faucets, and showerheads—with high-efficiency, low-volume alternatives. The implementation of these upgrades will result in reduced consumption of both water and thermal energy, decreased maintenance requirements, and enhanced fixture performance. Notably, high-efficiency toilets and urinals deliver substantial reductions in water use, while efficient aerators and showerheads contribute further water and energy savings without compromising occupant comfort.

- High Efficiency Toilets (HET): Commercial flush-valve UHETs operated at 1.28 gallons per flush (gpf), more than 20% lower than their 1.6 gpf predecessors and over 60% less than older high-flow toilets. Tank-type HETs featured flowrates ranging from 0.8 to 1.28 gpf.
- Urinals: Existing high efficiency urinals had flush rates from 0.125 gpf (pint-flush) to 0.5 gpf, reducing consumption by up to 90% compared to standard fixtures. Some ultra-low flow urinals (1/8 gpf) remained unchanged.
- Bathroom Faucets/Aerators: High efficiency aerators and flow restrictors were available from 0.35 gallons per minute (gpm) up to 1.5 gpm, allowing facilities to tailor water savings to their needs.
- Showerheads: High efficiency showerheads were installed with flow rates spanning from 1.25 gpm to 2.0 gpm, balancing water conservation with user satisfaction.

These targeted flowrates for toilets, urinals, faucets, and showerheads collectively drove substantial improvements in water efficiency throughout the facility.

Water and Energy Savings Calculations Methodology

The savings were calculated according to the following formulas:

Domestic Fixture Water/Sewer Savings

There are water and sewer savings specifically associated with the reduction in water use or water flow per fixture for domestic water fixture retrofits. The equations used are shown below:

Equations for Calculating Water/Sewer Savings for Domestic Water Fixtures

$$Water\ Savings = \sum_{type} [(Usage\ Rate_{baseline} - Usage\ Rate_{post}) \times AAUF_{type} \times Quantity_{type}] / 1000$$

$$AAUF = \sum_{population\ group} [(Male\ Daily\ Use_{population\ group} \times Number\ Males_{population\ group} + Female\ Daily\ Use_{population\ group} \times Number\ Females_{population\ group})] \times Avg\ Days\ per\ Year\ Occupied$$

where:

Water Savings =	water savings realized in kilogallons (kGal). These savings will result in water and sewer dollars saved.
Usage Rate$_{baseline}$ =	baseline fixture use rate in gpm (showers/faucets), or gpf (urinals/toilets)
Usage Rate$_{post}$ =	post installation fixture use rate in gpm (showers/faucets), or gpf (urinals/toilets)

AAUF = average annual use or flushes per fixture; faucets or showers in minutes per year, toilets or urinals in flushes per year =average people using x minutes/day (faucets/showers) or flushes/day (toilets/urinals) x days/year

Quantity = quantity of affected fixtures

Annual water and sewer cost savings are determined by multiplying the water kgal savings by the corresponding facility water and sewer rate ($/kgal).

The assumed Daily Use data for each fixture type and population group is in the table below:

Population Group	Gender	WATER CLOSET USE daily per person (flush)	URINAL USE daily per person (flush)	FAUCET USE daily per person (min)	SHOWER USE daily per person (min)
<2 hr Visitors	Male	0.35	0.15	0.06	0.05
	Female	0.50		0.06	0.05
<4 hr Visitors	Male	0.5	0.3	0.08	0.1
	Female	0.8		0.09	0.1
8 hr Regulars/Staff	Male	2.0	1.0	0.33	0.1
	Female	3.0		0.33	0.1
Emergency Services Staff	Male	2.0	1.0	0.6	8.2
	Female	3.0		0.8	8.2

The Population data (Number of Male/Female occupants) for each facility is in the table in the IGA document, as estimated by Johnson Controls (water balance calculations are performed for each facility to compare calculated water use to the actual water consumption baseline from the utility bills), as well as the Average Days per Year each facility is occupied. It is estimated that 50% of the population is male and 50% is female.

Hot Water Heating Energy Savings

Due to the reduction in domestic water use in showers and sinks, there will also be an associated reduction in hot water use and heating fuel/energy savings. These savings are only applied to fixtures that use hot water, and only in facilities that tend to use hot water (fire/police stations, aquatic centers).

A FIM to convert existing water heaters to Heat Pumps was not pursued due to existence of either Solar Thermal water heating or point of use instant hot water heaters.

Hot Water Heating Fuel Project Benefits

Energy Project Benefits =

$$\text{Water savings} \times (Temp_{hot} - Temp_{cold}) \times \text{Specific Heat} \times 1{,}000 / (3413 \times \text{Efficiency})$$

where:

Energy Project Benefits = Fuel savings realized in kWh

WaterProject Benefits$_{f\text{-}sh}$ =	water savings for faucets and showers in kGal
Temp$_{hot}$ =	average water temperature = 85°F (faucets), 106°F (showers)
Temp$_{cold}$ =	average cold water temperature = 75°F (for Maui, HI)
Specific Heat =	8.34 Btu / (kgal) (°F) for water
Efficiency =	Water heater efficiency expressed as a fraction = 98% for electric DHW heaters

Annual energy cost savings are determined by multiplying the kWh energy savings by the corresponding facility energy rate ($/kWh).

Electric DHW heaters are assumed to have an efficiency of 98%.

Measurement and Verification

The savings for this FIM will be verified using IPMVP-2016 Option A, Retrofit Isolation with Key Parameter Measurement. The savings for this FIM are generated through a reduction in water usage at the fixture; therefore, the measurement boundary is the fixture itself.

Key Parameter	Measurement Frequency	Measurement Description
Pre- retrofit Fixture gallons/flush gallons/minute	See *Energy Savings Calculations* section in the *FIM Descriptions*	The pre-retrofit flow rates were based upon measurements taken between 7/18/22 and 7/22/22 on a sample of fixtures that meet a confidence level of at least 80% and a precision of 20. These measurements form the basis for the baseline water consumption and will not be measured again.
Post-retrofit Fixture gallons/flush gallons/minute	Short-term	The post-installation fixture usages will be measured one time using the same measurement procedures. The measurements will occur in the same locations, up to the required sample size.
Estimated Parameters	**Assumed Value**	**Justification, Source and Description**
Population	See *Energy Savings Calculations* section in the *FIM Descriptions*	The population counts are estimated or based on information collected during site audits. These values will not be measured.
Usage Factors	See *Energy Savings Calculations* section in the *FIM Descriptions*	The usage factors (flushes/day/person, seconds/handwashing/usage, etc.) values are based on American Water Works Association Research Foundation (AWWARF), 2000, Commercial and Institutional End Uses of Water, and some engineering estimates.
Efficiency	See *Energy Savings Calculations* section in the *FIM Descriptions*	The efficiency of the hot water heating equipment is based on manufacturer's data and will not be measured.
Temp$_{hot}$	See *Energy Savings Calculations* section in the *FIM Descriptions*	The hot water temperature is the typical temperature at which users wash their hands and take showers and will not be measured.
Temp$_{cold}$	See *Energy Savings Calculations* section in the *FIM Descriptions*	The cold-water temperature is the average annual ground water temperature from Maui.

Performance Verification

This FIM is part of a one-time evaluation during the installation period; therefore, no M&V activities were conducted during Year 1 performance period. Below is a summary of the post-installation M&V activities that were conducted during installation. A total of 148 fixtures across nine usage groups were evaluated to compare pre- and post-measurement flow rates against their rated specifications. The analysis included toilets, urinals, faucets, showerheads, and shower towers, with flow expressed in gallons per flush (GPF) for toilets and urinals and gallons per minute (GPM) for faucets and showers. The objective was to assess pre- and post-measurement flow rates relative to rated specifications and quantify water savings achieved through retrofit measures. The findings indicate substantial reductions in water consumption, with savings ranging from 32% to 93% across all fixture types. Urinal flush valves and shower towers delivered the most significant improvements, while toilets and faucets also demonstrated meaningful reductions. Post-retrofit flows consistently fell below rated values, confirming the effectiveness of conservation strategies and highlighting opportunities for long-term cost and resource savings. Highlights include:

- Significant reductions in water consumption were achieved across all categories, ranging from 32% to 93%.
- Urinal flush valves demonstrated the highest savings, with reductions of 92–93%, primarily due to ultra-low or waterless solutions.
- Shower towers showed substantial improvements, with one type reducing flow by 91% (16.75 to 1.52 GPM).
- Faucets and showerheads achieved reductions of 86% and 70%, respectively, indicating strong conservation measures.
- Toilet fixtures exhibited moderate reductions, between 32% and 53%, with post-measurement flows generally below rated specifications.

Post-retrofit flows were consistently reduced to below rated values, confirming effective implementation of water-saving strategies.

Table 5.1: Pre & Post Flowrate Measurements Summary

Usage Group	Samples	Rated Flowrate	Pre-Measurement Flowrate	Post-Measurement Flowrate	Reductions %
1.6 GPF Toilet Flush Valve	17	1.6	2.26	1.07	53%
1.28 GPF Toilet Flush Valve	17	1.28	1.95	1.20	39%
1.6 GPF Toilet TANK Type	17	1.6	1.66	1.14	32%
1.0 GPF Urinal Flush Valve	17	1	1.53	0.12	92%
1.5 GPF Urinal Flush Valve	12	1.5	1.74	0.12	93%
2.2 GPM Faucets	17	2.2	3.49	0.49	86%
2.5 GPM Showerhead	17	2.5	4.32	1.31	70%
Shower Towers	17		6.12	2.00	67%
Shower Towers	17		16.75	1.52	91%
Total	**148**				

Verified Savings

Energy savings for FIM 5 resulted in $11,935, more than initially expected. This increase is due to the installation of additional water fixtures (119 fixtures: 11 aerators, 15 showers, 75 toilets, 18 urinals) at the project site, while the guaranteed savings per the revised IGA remained unchanged. The cost savings were updated to reflect Year 1 rates.

Table 5.2: Domestic Water Plumbing Savings Summary

	Electric Savings (kWh)	Electric Cost Savings ($)	Water + Sewer Savings (kGal)	Water + Sewer Savings ($)	Total Proposed Cost Savings ($)
Proposed Original IGA	141,801	$ 56,751	29,999	$ 139,828	$ 196,580
Revised IGA	34,003	$ 13,665	22,570	$ 96,825	$ 110,489
Verified Year 1	45,822	$ 18,110	26,070	$ 104,314	$ 122,424
Variance (Verified Year 1 - Revised IGA)	11,819	$ 4,445	3,500	$ 7,490	$ 11,935

FIM 6: Shower Tower Retrofits

FIM Description

A During the development phase, water consumption at beach shower towers increased by approximately 35%. This higher usage was compounded by incidents of vandalism and frequent use by visitors and non-beach users beyond designated hours. To address these challenges and improve water efficiency, the original shower towers were replaced with low-flow models featuring a maximum flow rate of 2.5 gallons per minute.

All beach parks reported significant vandalism to plumbing fixtures. In response, future installations were recommended to use institutional-grade shower towers equipped with pressure-compensating spray nozzles designed for vandal resistance. These commercial-grade fixtures feature durable, non-porous polymer that resists rust and vandalism, include recessed anchor holes for safety, withstand extreme cold, and are ADA compliant. Colors are fade-resistant and minor damage can be heat blended.

Energy/Water Savings Calculations Methodology

The savings were calculated according to the following formulas:

Shower Tower Water/Sewer Savings

There are water and sewer savings specifically associated with the reduction in water use or water flow per fixture for domestic water fixture retrofits. The equations used are shown below:

Equations for Calculating Water/Sewer Savings for Domestic Water Fixtures

$$Water\ Savings = [\ (Usage\ Rate_{baseline} - Usage\ Rate_{post})\ x\ AAUF\ x\ Quantity] / 1000$$

$$AAUF = Number\ of\ Users\ x\ Avg\ Days\ per\ Year\ x\ Shower\ Use\ (min/use)$$

where:

Water Savings =	water savings realized in kilogallons (kGal). These savings will result in water and sewer dollars saved.
Usage Rate$_{baseline}$ =	baseline fixture use rate in gpm (showers),
Usage Rate$_{post}$ =	post installation fixture use rate in gpm (showers),
AAUF =	average annual use for showers in minutes per year = Number of people using x minutes/day (showers)
Quantity =	quantity of affected fixtures

The number of people using the showers are estimated according to the annual water baseline provided by the County for each park.

Annual water and sewer cost savings are determined by multiplying the water kgal savings by the corresponding facility water and sewer rate ($/kgal).

The assumed Daily Use data is in the table below:

Location	QTY	TYPE	Days per Year	Number of Users	Shower Use (min)	AAUF
Charley Young	1	Manual	365	16.9	2.00	12,337
DT Fleming Park	1	Push Button	365	85	2.00	62,050
H A Baldwin	1	Push Button	365	116	2.00	84,680
Hanakao'o Park	2	Manual	365	228	2.00	166,440
Haycraft Park	1	Push Button	365	104	2.00	75,920
Honokowai Beach Park	1	Push Button	365	212	2.00	154,760
Hookipa Beach Park	1	Push Button	365	87	2.00	63,510
Hookipa Beach Park	1	Manual	365	87	2.00	63,510
Kalama Park	1	Manual	365	78	2.00	56,940
Kamaole I Beach Park	1	Push Button	365	360	2.00	262,800
Kamaole II Beach Park	1	Push Button	365	190	2.00	138,700
Kamaole III Beach Park	3	Push Button	365	295	2.00	215,350
Kanaha Beach Park	1	Manual	365	155	2.00	113,150
Kihei Aquatic Center	2	Push Button	365	55	2.00	40,150
Launiupoko Beach Park	1	Push Button	365	1925	2.00	1,405,250
Lower Paia Park	1	Push Button	365	210	2.00	153,300
Papohaku Beach Park	1	Manual	365	60	2.00	43,800
Papohaku Beach Park	2	Manual - Copper Shower Repipe	365	30	2.00	21,900
Wahikuli Wayside Park	1	Manual	365	100	5.00	182,500
Wailea Beach Park	1	Push Button	365	650	2.00	474,500
TOTAL	**25**					

Measurement and Verification

The savings for this FIM will be verified using IPMVP-2016 Option A, Retrofit Isolation with Key Parameter Measurement. The savings for this FIM are generated through a reduction in water usage at the fixture; therefore, the measurement boundary is the fixture itself.

Key Parameter	Measurement Frequency	Measurement Description
Pre- retrofit Fixture gallons/flush gallons/minute	See *Energy Savings Calculations* section in the *FIM Descriptions*	The pre-retrofit flow rates were based upon measurements taken between 7/18/22 and 7/22/22 on a sample of fixtures that meet a confidence level of at least 80% and a precision of 20. These measurements form the basis for the baseline water consumption and will not be measured again.
Post-retrofit Fixture gallons/flush gallons/minute	Short-term	The post-installation fixture usages will be measured one time using the same measurement procedures. The measurements will occur in the same locations, up to the required sample size.
Estimated Parameters	**Assumed Value**	**Justification, Source and Description**
Population	See *Energy Savings Calculations* section in the *FIM Descriptions*	The population counts are estimated or based on information collected during site audits. These values will not be measured.
Usage Factors	See *Energy Savings Calculations* section in the *FIM Descriptions*	The usage factors (flushes/day/person, seconds/handwashing/usage, etc.) values are based on American Water Works Association Research Foundation (AWWARF), 2000, Commercial and Institutional End Uses of Water, and some engineering estimates.
Efficiency	See *Energy Savings Calculations* section in the *FIM Descriptions*	The efficiency of the hot water heating equipment is based on manufacturer's data and will not be measured.
$Temp_{hot}$	See *Energy Savings Calculations* section in the *FIM Descriptions*	The hot water temperature is the typical temperature at which users wash their hands and take showers and will not be measured.
$Temp_{cold}$	See *Energy Savings Calculations* section in the *FIM Descriptions*	The cold-water temperature is the average annual ground water temperature from Maui.

Performance Verification

This FIM was assessed as part of a one-time evaluation during the installation phase; therefore, no M&V activities occurred during the first-year performance period. The analysis focused on comparing Push Button and Manual Shower Towers across multiple sites. Measurements of flush and flow rates (in gallons per minute) were taken during installation and applied to update water savings calculations.

Push Button	ShowerTowers		
	SIte Name	Location	Flush / Flow Rate
1	Kihei Aquatic	outside	**1.60**
2	Kihei Aquatic	outside	**2.20**
3	kamaole 3 beach park	outside	**2.50**
4	honokowai beach park	outside	**2.50**
10	wailea beach park	outside	**1.50**
17	laniupoko beack park	outside	**8.75**
		Average Usage	**3.18**

Manual	ShowerTowers		
	SIte Name	Location	Flush / Flow Rate
4	charley Young		**1.50**
5	hanakaoo park	outside	**3.00**
6	hanakaoo park	outside	**3.00**
7	kalama park	outside	**1.50**
8	kalama park	outside	**1.50**
		Average Usage	**2.73**

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Verified Savings

The savings increased significantly by $72,273. This increase is attributed to better performance of the shower fixtures (actual flow rate) and due to adjustment of the baseline water consumption of the shower towers, triggered by the discovery of missing water bills for four meters at Kalama Park, Kamaole 1 and 2 Beach Parks, and Kanaha Beach Park.

The water usage at these sites increased from 87 million to 97 million gallons, an 11% rise, leading to a 15% increase in the baseline usage of the shower towers. While the post-installation usage remained the same, the increase in baseline usage altered the water savings calculation, resulting in significantly higher water savings.

Table 6.1: Shower Towers Savings Summary

	Water + Sewer Savings (kGal)	Water + Sewer Savings ($)	Total Proposed Cost Savings ($)
Proposed Original IGA	**73,736**	**$ 304,789**	**$ 304,789**
Revised IGA	**54,005**	**$ 150,224**	**$ 150,224**
Verified Year 1	**57,928**	**$ 222,497**	**$ 222,497**
Variance (Verified Year 1 - Revised IGA)	**3,923**	**$ 72,273**	**$ 72,273**

Operational Verification (OV) Approach:

OV approach provides verification of a system's capability to produce the projected energy savings.

Detailed M&V isn't cost effective for the On-Site Hypochlorite Generation and Infiltration Reduction due to the relatively small amount of energy savings attributed to these FIMs. Therefore, Post-installation M&V was conducted to verifying installation of the FIMs as outlined below.

FIM	Frequency	Task Description
Irrigation System	One Time – Post Installation	*Post Installation* • Visually verify and document via digital photographs the operation of the irrigation controller.
On-Site Hypochlorite Generation	One Time – Post installation	See *Energy Savings Calculations* section in the *FIM Descriptions* *Post Installation* • Onsite chlorine generator (Verify nameplate data). • Visually verify and document salt use to generate chlorine. Review the functional testing documents associated with the installation.
Infiltration Reduction	One Time – Post installation	*Post Installation* • Visually verify and document via digital photographs the areas affected by the envelope improvements. Review the pre and post leakage area (sqft).

FIM 7: Irrigation Systems

FIM Description

New Irrigation System at Kelawea Mauka Makai Park:

- Provide and Install new irrigation system, including: new valves following the original design with no additional areas.
- Provide dirt removal and replacement and re-seeding using hydroseed with Common Bermuda seed. Areas to be covered are the main effected area, which include the effected areas as well as all slopes and hillsides (approx.. 44,480 sqft), and the main ball field area as well (approx. 33,600 sqft)
- Provide and Install new battery-operated Hunter Bluetooth nodes in each valve box.
- Existing irrigation pipes will be abandoned in place, with the exception of anything that interferes with the new installation.
- Provide As-Built drawings showing the irrigation layout upon completion of the work.

Exclusions:

- Existing irrigation system and controls shall be re-used
- Excludes tree trimming or tree removal.

Water Savings Calculations

Irrigation System Water Savings

There are savings specifically associated with the new irrigation system at Kelawea Mauka Makai Park due to the elimination of the leaks in the existing irrigation system. The existing system has piping that are buried too deep and is suspected of leaking by the Parks Department.

<u>Equations for Calculating Irrigation System Replacement Water Savings</u>

Water kGal Savings = Water Baseline (kgal/yr) – New Water Use (kgal/yr)

Period Water Use (kGal/yr) = Qty Heads x GPM/Head x Min/Cycle x Cycles/week x Weeks/year / 1000

Total Water Use (kGal/yr) = Period 1 Water Use + Period 2 Water Use

Where:

Qty Heads =	Quantity of rotor heads as observed during a site visit
GPM/Head =	Estimated Flow per rotor/head based on existing models being used (Hunter Ultra Max rotor heads 360deg) with an assumed pressure of 45 psi.
Minutes/day =	Estimated duration of irrigation system operation per day. (Data provided by Department of Parks irrigation onsite indicated 20-40 minutes/day, and worst case scenario of 40 minutes/day was used in this analysis to be conservative).

Cycles/Week = Frequency of irrigation system operation per week. Data provided by Department of Parks irrigation onsite indicated that for about 3 months/year the system is only used 3 days/week and the rest of the time it's 5 days/week.

Water Baseline = Annual water use from water bills from April 2021 to March 2022.

Total Water Use = Total amount of water the irrigation system should use per year

The table below provides a calculation of the water savings:

Kelawea Mauka Park					Period 1			Period 2			
Zone	**Rotor Heads**	**Assumed PSI**	**Degrees**	**GPM**	**Minutes per cycle**	**Days per Week**	**Weeks per Year**	**Minutes per cycle**	**Days per Week**	**Weeks per Year**	**Total Water use (kgal)**
Box 1	6	45	360	5.78	40	5	39	40	3	13	324.60
"	7	45	360	5.78	40	5	39	40	3	13	378.71
Box 2	7	45	360	5.78	40	5	39	40	3	13	378.71
Box 3	6	45	360	5.78	40	5	39	40	3	13	324.60
Box 4	4	45	360	5.78	40	5	39	40	3	13	216.40
Box 5	6	45	360	5.78	40	5	39	40	3	13	324.60
Box 6	5	45	360	5.78	40	5	39	40	3	13	270.50
Box 7	5	45	360	5.78	40	5	39	40	3	13	270.50
Box 8	8	45	360	5.78	40	5	39	40	3	13	432.81
Sprayheads	20	45	360	1.2	40	5	39	40	3	13	224.64
Box 9	6	45	360	5.78	40	5	39	40	3	13	324.60
Sprayheads	20	45	360	1.2	40	5	39	40	3	13	224.64
Box 10	6	45	360	5.78	40	5	39	40	3	13	324.60
Box 11	6	45	360	5.78	40	5	39	40	3	13	324.60
Total Calculated Water use											**4,344.54**
Utility Baseline Water Use (Apr '21 to Mar '22)											**6,008.00**
Savings (non-measured) = Calculated Use - Utility Baseline											**1,663.46**

Measurement and Verification

Water savings resulting from the elimination of water leaks on the existing irrigation system are not cost effective to measure and verify, thus with the methodology described above, the Customer agrees that the savings generated through this new irrigation system will be achieved. These savings will not be measured.

FIM	Frequency	Task Description
Irrigation System	One Time – Post Installation	*Post Installation* • Visually verify and document via digital photographs the operation of the irrigation controller.

Performance Verification

This FIM is part of a one-time evaluation during the installation period; therefore, no M&V activities were conducted during Year 1 performance period.

Verified Savings

The non-energy savings amount to 1,663 kGals, resulting in total cost savings of $10,026 attributed to changes of the irrigation system, as detailed in Table 7.1. The following table provides a breakdown of these savings during Year 1.

Table 7.1: Irrigation Systems Savings Summary

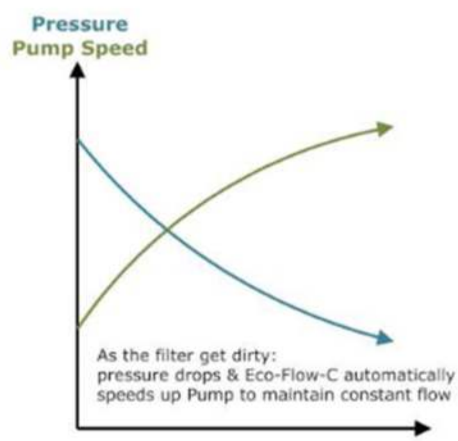
	Electric Savings (kWh)	Electric Cost Savings ($)	Water + Sewer Savings (kGal)	Water + Sewer Savings ($)	Total Proposed Cost Savings ($)
Proposed Original IGA	(61,908)	$ (25,953)	64,046	$ 335,764	$ 309,811
Revised IGA	-	$ -	1,663	$ 10,026	$ 10,026
Verified Year 1	-	$ -	1,663	$ 10,026	$ 10,026
Variance (Verified Year 1 - Revised IGA)	-	$ -	-	$ -	$ -

FIM 8: On-Site Hypochlorite Generation and Smart Pool Pump Controls

FIM Description

The proposed improvements included: install Smart Pump control systems with integration to Aquatic Systems, install On-Site Hypochlorite Generation (OSHG), install water chemistry controllers, and repair some of the noted deficiencies with the existing pool systems.

The Smart Pump control system with integration to aquatic systems provides system level control. This will simplify operations and save energy. Flow measuring devices will be installed and integrated into the control system. Knowing the flow is a critical aspect of maintaining efficient and effective pool filtration. The Smart Pump control system will use the flow rate to automatically adjust the speed of the pump to maintain the desired flow. The pump speed needed will change with the filter condition. Energy savings is achieved by matching the pump performance to the filter load as it dynamically changes during the filter cycle.



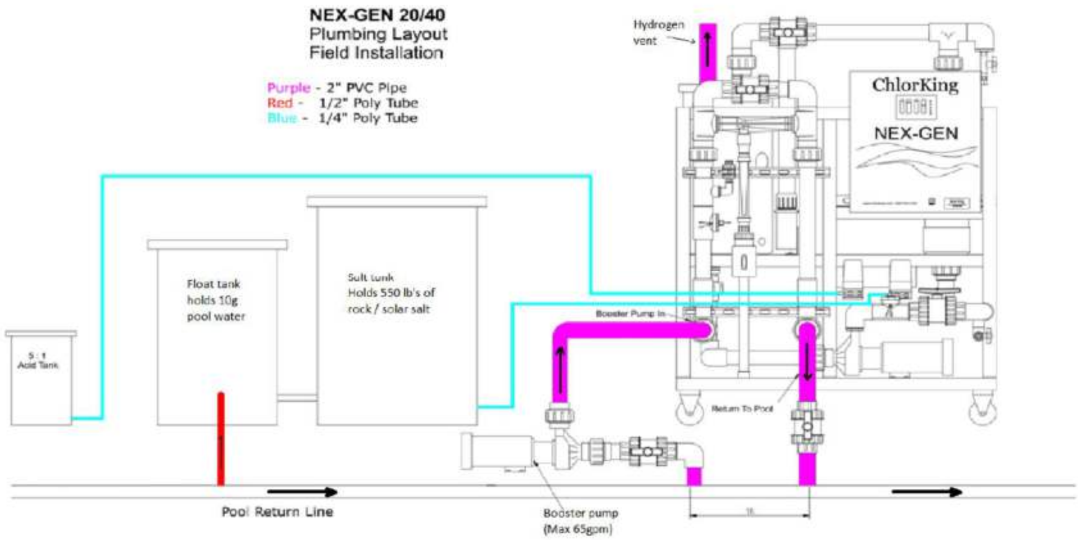
On-Site Sodium Hypochlorite Generation replaces the existing method of buying and storing chlorine for water treatment. The hypochlorite needed for pool water treatment is produced on-site and the need to purchase and store expensive chlorine is eliminated.

Sodium hypochlorite generators produce pool chlorination chemicals from the electrochemical reaction between salt, water, and electricity. On-site production of chlorine as a solution of sodium hypochlorite alleviates the risks to public health and safety relating to the storage and transportation of hazardous acid and concentrated chlorine solutions. The only raw material, salt, is an inert, safe compound that is stored in a feeder on-site and used as required by the chlorine generator.

On-site generation systems create a pH neutral chlorine. The pH neutral chlorine from OSHG reduces the need for chemicals such as CO2 / Muriatic/ Sulfuric Acids by 50% that are required to control pH in traditional chlorination systems.

Traditional chlorination systems introduce high levels of Calcium into the pool water. The amount of Calcium and other minerals is measured as Total Dissolved Solids (TDS). High TDS requires dilution with makeup water to keep it below the required amount. OSHG greatly reduces the TDS in pool water and is needed for dilution.

The system uses pool water (not make-up water) to determine how much sodium hypochlorite to add. This results in a more precise control of the pool chorine levels. By using pool water directly there is residual sodium already in the water. Thus, if the pool isn't drained, less salt will be required each year.



Water chemistry controllers will automate water treatment for the pools. The controllers will monitor and control the pool pH and Free Available Chlorine (FAC). Pool chemistry controllers will provide consistency across locations by automating a task that is currently manually performed by different people.

Water and Energy Savings Calculations

OSHG Water/Sewer Savings
OSHG reduces the amount of make-up water needed to dilute TDS in pools. The post-retrofit reduction is because Calcium Hypochlorite is 35% calcium by weight and will no longer be added to the pool water.

The Water/Sewer Savings are calculated with the following methodology and assumptions:

$$kGal_{Savings} = \text{Pool Volume} / 1000 \text{ (Gal/kGal)} \times \text{Dilution} \times 12 \text{ (months/year)}$$
$$Water_{Savings} = kGal_{Savings} \times \text{Water Rate}$$
$$Sewer_{Savings} = kGal_{Savings} \times \text{Sewer Rate}$$

Where:

Pool Volume = *Total volume of the pool (Gal)*

Dilution = *Percent of pool volume needed to be replaced monthly to keep calcium below 500 ppm = 13.7%*

$Water_{Rate}$ = *Marginal water rate ($/kGal)*

$Sewer_{Rate}$ = *Sewer rate ($/kGal) = $6.7/kgal (where applicable)*

And:

$$\text{Dilution} = \text{Max Calcium} / [\text{Max Calcium} + (CalHypo_{Daily\ Addition} \times Calcium_{CalHypo}) \times 30 \text{ day/month}]$$

Max Calcium = *500 (ppm)*

$CalHypo_{DailyAddition}$ = *Daily chemical addition to pool = 8 (ppm)*

$Calcium_{CalHypo}$ = *Calcium by weight of Calcium Hypochlorite = 35%*

Dilution = *13.7%*

The water/sewer savings associated with the OSHG will not be measured, and below is a table showing the total water/sewer savings at baseline rates:

Facility	Pool Volume (Gal)	$kGal_{Savings}$ (kGal/Yr)	$Water_{Rate}$ ($/kGal)	$Sewer_{Rate}$ ($/kGal)	$Water_{Savings}$ ($/yr)	$Sewer_{Savings}$ ($/yr)	Total Savings ($/yr)
Coach Sakamoto Pool	410,670	675	$5.85	$0.00	$3,950	$0	$3,950
Cooke Memorial Pool	184,000	444	$3.90	$0.00	$1,731	$0	$1,731
Kokua Pool	190,000	N/A	$5.85	$6.70	N/A	N/A	N/A
Kihei Aquatic Center	1,057,500	1,739	$5.85	$6.70	$10,170	$11,648	$21,819
Lahaina Aquatic Center	522,300	859	$5.85	$6.70	$5,023	$5,753	$10,776
Upcountry Pool	453,588	746	$5.85	$0.00	$4,362	$0	$4,362
Wailuku Pool	40,000	66	$5.85	$0.00	$385	$0	$385
TOTAL	**2,944,058**	**4,529**			**$25,621**	**$17,401**	**$43,023**

OSHG Electric Penalty

OSHG will increase the electric usage at the pool facilities. This increase is because the chemical is being produced on-site by new equipment that uses electricity. The energy of the new equipment is partially offset by the removal of the existing Chloride Pump.

First calculate the post-retrofit penalty for new electrical usage by the OSHG equipment:

$$OSHG_{Elec} = Volt_{OSHG} \times Amp_{OSHG} / 1000 \text{(W/kW)} \times Hour_{OSHG} \times \text{Days of Operation}$$

And:

$$Hour_{OSHG} = \text{FAC Use} / OSHG_{Capacity} \times 24 \text{ (hr/day)}$$

Where:

$Volts_{OSHG}$ = Voltage of OSHG Equipment = 208V
Days of Operation = Days of Operation per year = 365

The electric penalty associated with the OSHG will not be measured, and below is a table showing the assumptions and results:

Facility	$OSHG_{Capacity}$ (lb/day)	Amp_{OSHG} (A)	FAC Use (lb/day)	$Hour_{OSHG}$ (hr/day)	$OSHG_{Elec}$ (kWh/Yr)	Elec Rate ($/kWh)	Penalty ($/yr)
Coach Sakamoto Pool	180	88	17.55	2.34	15,633	0.32663	**$5,106**
Cooke Memorial Pool	60	30	11.7	4.68	10,659	0.383907	**$4,092**
Kokua Pool	N/A	N/A	N/A	N/A	N/A	0.32663	**N/A**
Kihei Aquatic Center	240	116	46.15	4.62	40,643	0.32663	**$13,275**
Lahaina Aquatic Center	180	88	22.75	3.03	20,266	0.32663	**$6,619**
Upcountry Pool	180	88	17.55	2.34	15,633	0.372881	**$5,829**
Wailuku Pool	12	6	2.6	5.2	2,369	0.32663	**$774**
Total	**852**	**416**	**118.3**	**22.21**	**105,203**		**$35,695**

Chloride Pump Savings
Below are the savings generated by the removal of the chloride pump:

$Chloride\ Pump_{Elec}$ = $Volt_{ChlorPump}$ x $Amp_{ChlorPump}$ / 1000(W/kW) x $Hour_{ChlorPump}$ x Days of Operation x Quantity

Where:

$Volt_{ChlorPump}$ = 120 (V)
$Amp_{ChlorPump}$ = 5 (A) (Estimated size of chloride pump)
$Hour_{ChlorPump}$ = 8 (hr/day)
Days of Operation = 365 (day/year)
**Quantity = 7*
**No Chloride Pump at Coach Shiraishi Memorial Pool*

The electric savings associated with the removal of the chloride pumps will not be measured. Below are the results.

$Chloride\ Pump_{Elec}$ = 12,264 (kWh/yr)

Facility	Chloride $Pump_{Elec}$ (kWh/Yr)	Elec Rate ($/kWh)	Chloride Pump Savings ($/yr)
Coach Sakamoto Pool	1,752	0.32663	**$572**
Cooke Memorial Pool	1,752	0.383907	**$673**
Kokua Pool	N/A	0.32663	**N/A**
Kihei Aquatic Center	1,752	0.32663	**$572**
Lahaina Aquatic Center	1,752	0.32663	**$572**
Upcountry Pool	1,752	0.372881	**$653**
Wailuku Pool	1,752	0.32663	**$572**
Total	**10,512**		**$3,614**

Smart Pool Pump Control Electric Savings
The Smart Pump control systems will reduce the electric usage at the pool facilities. The savings will come from reducing pump energy by varying the speed needed to maintain desired flow.

Next determine the Pool Pump baseline electricity use (kWh):

$$Pool\ Pump_{Pre} = (Flow \times Head) / (3{,}960 \times Motor_{Eff} \times Pump_{Eff}) \times .746\ (kW/hp) \times Days\ of\ Operation \times Hour_{On} \times Qty$$

Where:

Flow = *Nameplate (gpm)*
Head = *Nameplate (Ft)*
Conversion Factor *3,960*
$Motor_{Eff}$ = *Motor Efficiency (%)*
$Pump_{Eff}$ = *Pump Efficiency (%)*
Days of Operation = *Days of operation per year = 365 day/year*
$Hour_{On}$ = *Hours of operation per day = 24hr/day*
Qty = *Number of identical pumps*

Facility	Location	Pump Flow (gpm)	Pump Head (ft)	Motor Efficiency (%)	Pump Efficiency (%)	Qty	Pool Pump$_{Pre}$ (kWh/yr)
Coach Sakamoto Pool	Lap Pool	1,300	65	92.40%	92.40%	1	163,328
Coach Siraishi Pool	Lap Pool	405	60	87.50%	87.50%	1	52,377
Cooke Memorial Pool	Lap Pool	200	80	87.50%	87.50%	2	68,973
Kihei Aquatic Center	Lap Pool	1,200	60	91.00%	91.00%	2	286,964
Kihei Aquatic Center	Training Pool	500	60	92.40%	92.40%	1	57,986
Kihei Aquatic Center	Keiki Pool	200	60	85.50%	85.50%	1	27,089
Kihei Aquatic Center	Keiki Feature	500	50	88.50%	88.50%	1	15,363
Lahaina Aquatic Center	Lap Pool	1,428	70	94.50%	94.50%	2	369,437
Lahaina Aquatic Center	Keiki Pool	135	60	91.00%	91.00%	1	16,142
Upcountry Pool	Lap Pool	1,142	50	89.50%	89.50%	1	117,635
Upcountry Pool	Teaching Pool	180	70	89.00%	89.00%	1	26,251
Upcountry Pool	Keiki Pool	110	60	89.00%	89.00%	1	13,750
Wailuku Pool	Lap Pool	95	60	87.00%	87.00%	2	24,855
Total							**1,240,150**

The Pool Pump Post electrical usage is calculated as:

$$Pool\ Pump_{Post} = Days\ of\ Operation \times [(Pump\ kW_{Occ} \times Hour_{Occ}) + (Pump\ kW_{Unocc} \times Hour_{Unocc})]$$

Where:

Days of Operation, Occupied hours, and Unoccupied hours will not be measured and the following table of values is used.

Days of Operation = *Days of Operation per year = 365 (day/yr)*

$Hour_{Occ}$ = *Occupied Hours per day = 7 (hr/day)*

$Hour_{Unocc}$ = *Unoccupied Hours per day = 17 (hr/day)*

The Pool pump savings are simply calculated as:

$$\text{Pool Pump}_{Savings} = \text{Pool Pump}_{Pre} - \text{Pool Pump}_{Post}$$

Measurement and Verification

There are 2 M&V methodology for this FIM, Operational Verification M&V and IPMVP-2016 Option A.

For the OSHG water/sewer savings, OSHG pump penalty and chloride pumps saving, there will be a one-time post installation Operational Verification M&V.

FIM	Frequency	Task Description
Irrigation System	One Time – Post Installation	*Post Installation* • Visually verify and document via digital photographs the operation of the irrigation controller.
On-Site Hypochlorite Generation	One Time – Post installation	See *Energy Savings Calculations* section in the *FIM Descriptions* *Post Installation* • Onsite chlorine generator (Verify nameplate data). • Visually verify and document salt use to generate chlorine. Review the functional testing documents associated with the installation.

For the smart pump controls, the savings will be verified using IPMVP-2016 Option A, Retrofit Isolation with Key Parameter Measurement. The savings for this FIM are generated through a reduction in pump kW via VFDs and pump controllers; therefore, the measurement boundary is the pump itself.

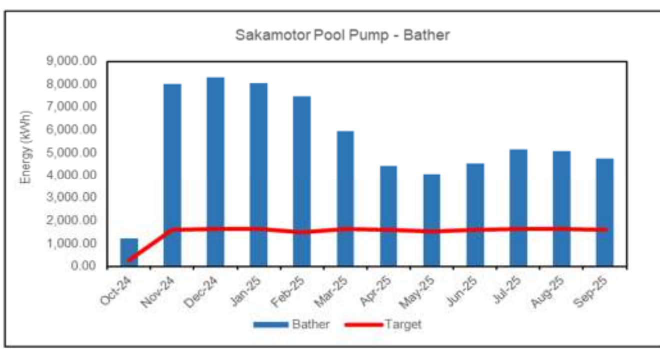
Key Parameter	Measurement Frequency	Measurement Description
Post-Retrofit kW	Short-term	Quarterly the power reads will be read via controller with remote access during hours of non-bathing and bathing periods to average over the year to illustrate reduced pump speed.
Estimated Parameters	**Assumed Value**	**Justification, Source and Description**
Baseline kWh	See *Energy Savings Calculations* section in the *FIM Descriptions*	The pre-retrofit pool pump energy use is based on the calculations shown. These values form the basis for the baseline pool pump energy use and will not be measured.
Run Hours – Baseline and Post-Retrofit	See *Energy Savings Calculations* section in the *FIM Descriptions*	It is agreed that the pumps operate 24 hours per day, 365 days per year. 7 hours per day in the "occupied/pool in use" and 17 hours per day in the "unoccupied" mode.

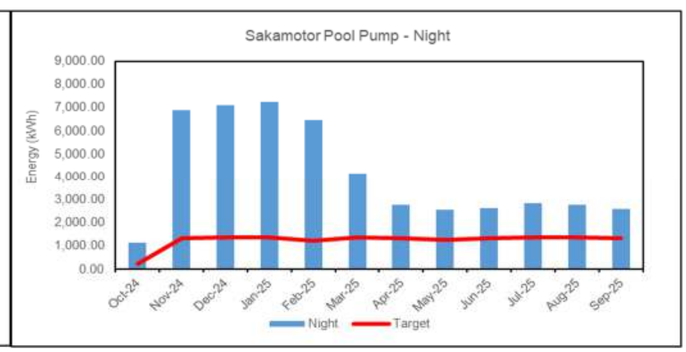
Performance Verification

During Year 1, the implementation of smart pump controls across Maui County aquatic facilities demonstrated measurable progress toward energy savings objectives. Several pools successfully reduced pump speeds during unoccupied periods, aligning with project overall goals. However, optimization remains an area for improvement at few sites. Johnson Controls (JCI) will continue monitoring and fine-tuning pump operations to achieve targeted performance and maximize savings. The savings associated with this measure were verified by confirming equipment power output during the performance period. Observations and actions for each facility are summarized below:

Coach Soichi Sakamoto Pool

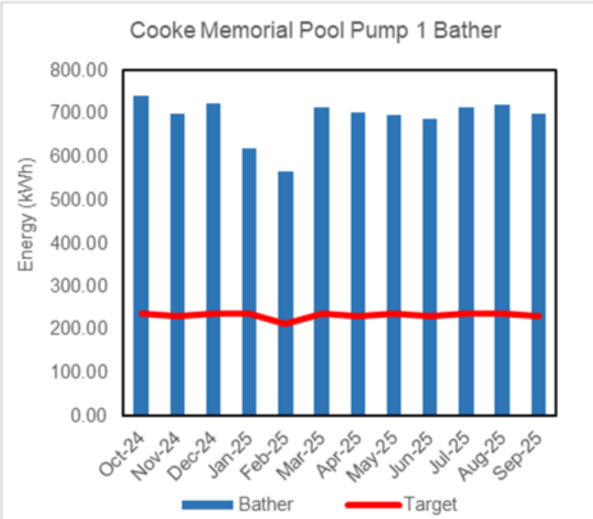
Pump control improvements began in March 2025, with enhanced performance during unoccupied periods as shown in trend data. JCI will continue monitoring to achieve targeted reductions during occupied hours.

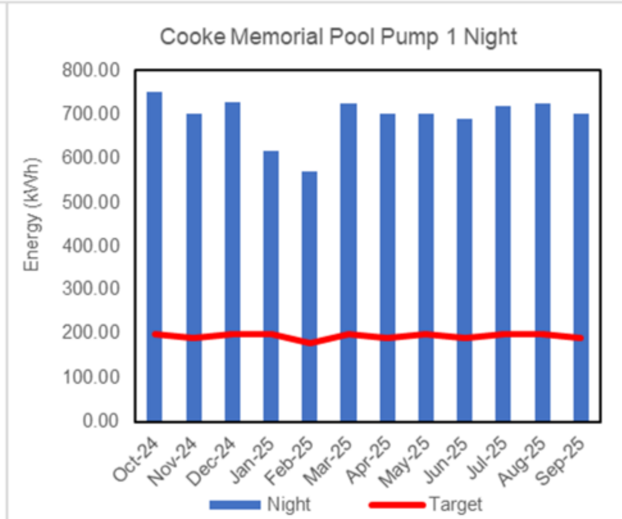


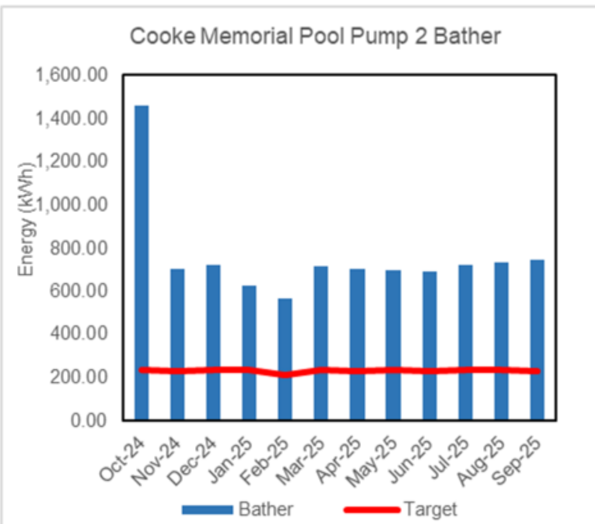


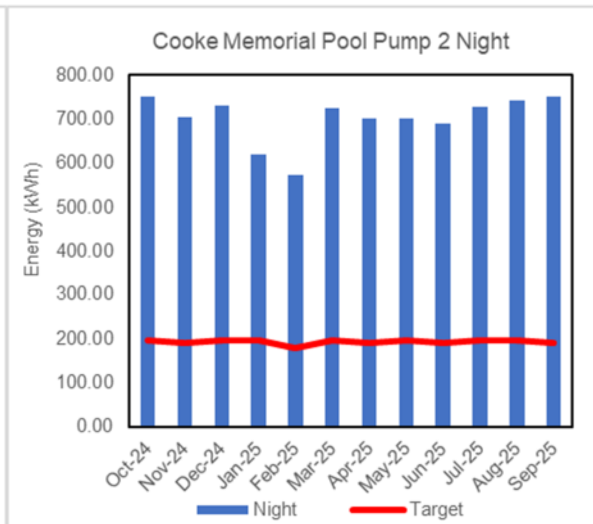
Cooke

Both pumps 1 & 2 are not reducing speeds in unoccupied mode during night operations.



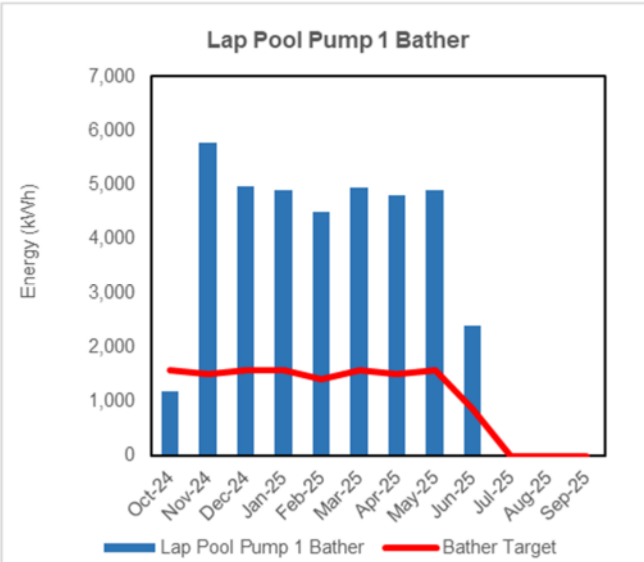


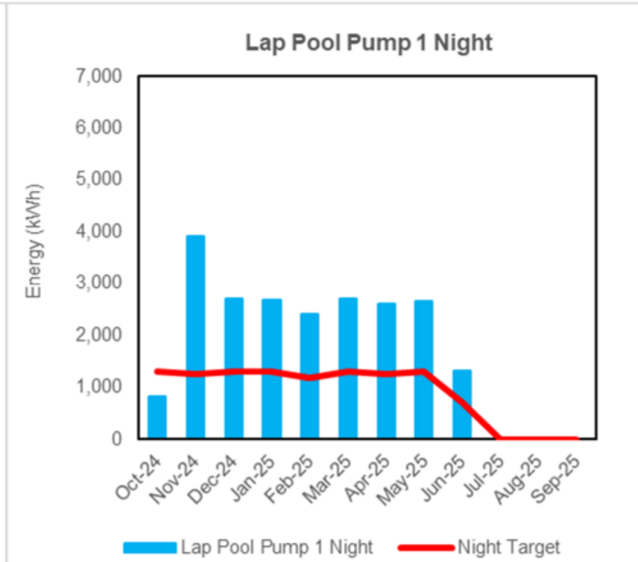


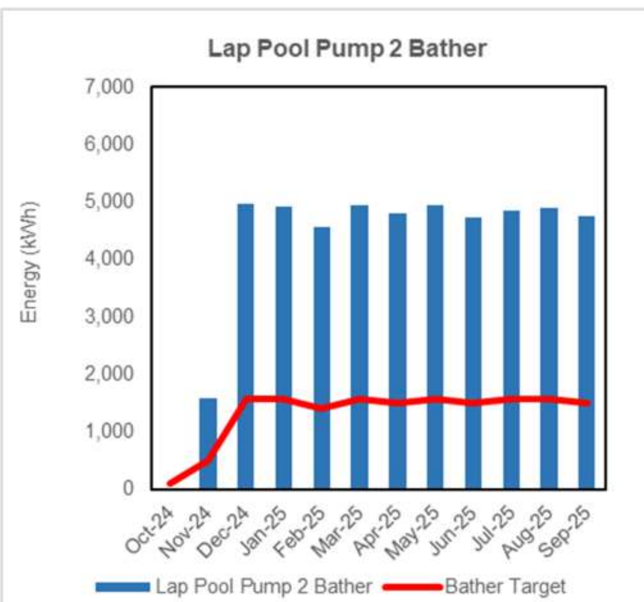


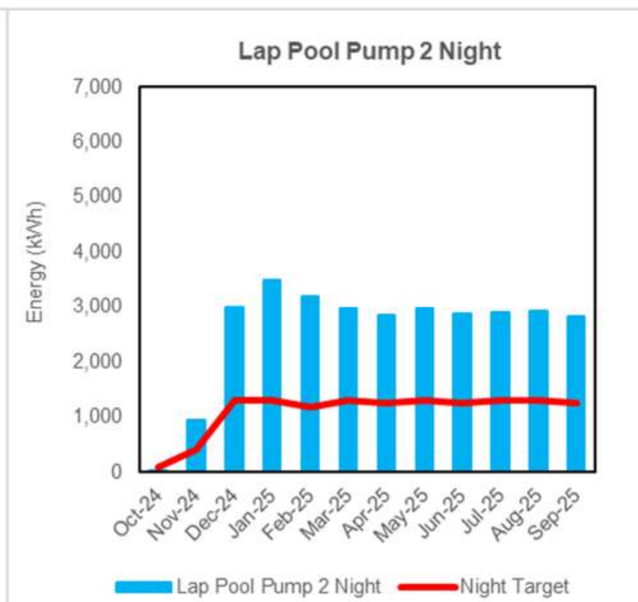
Khei

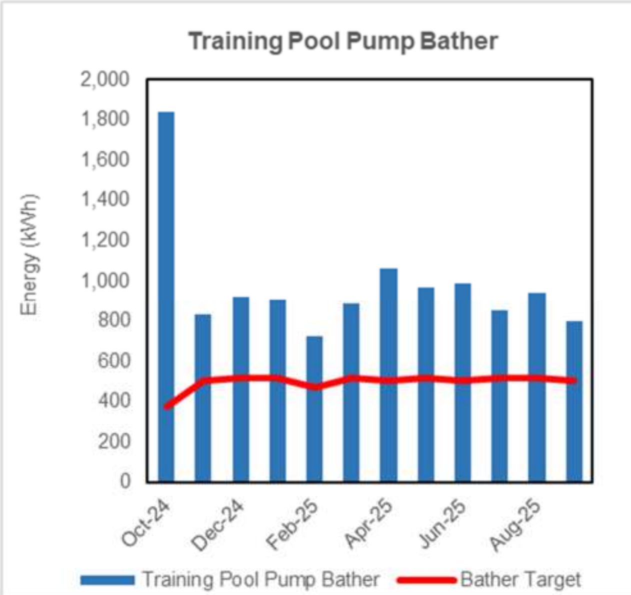
All pumps operated at reduced speeds during unoccupied nighttime periods. JCI will maintain oversight of Lap Pool Pumps 1 and 2 to further optimize speed reductions during occupied hours. According to the Maui Pool Maintenance Manager, Lap Pool Pump 1 at Kihei Pool was out of service due to a failed variable frequency drive (VFD). The VFD was replaced in October, and the pump is now operational. The Eclypse control system will require rewiring to the new VFD to resume trend data collection.



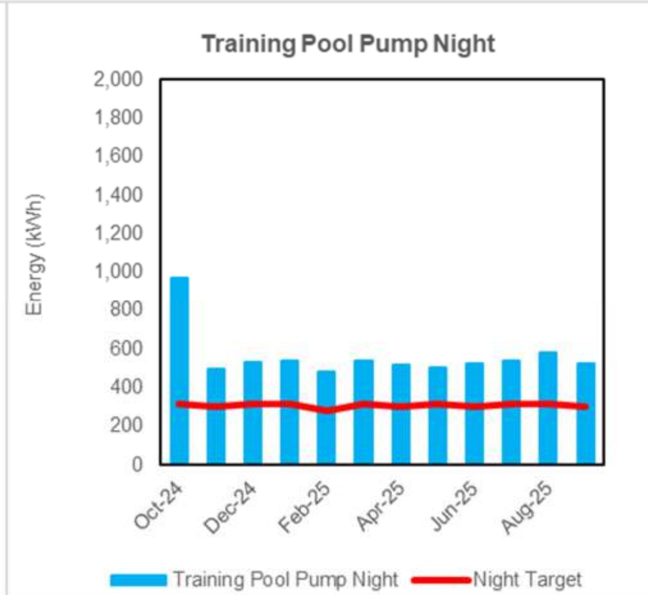




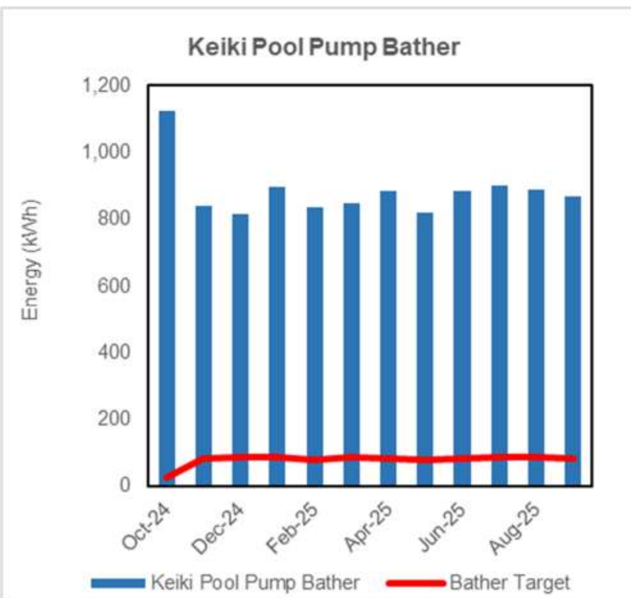




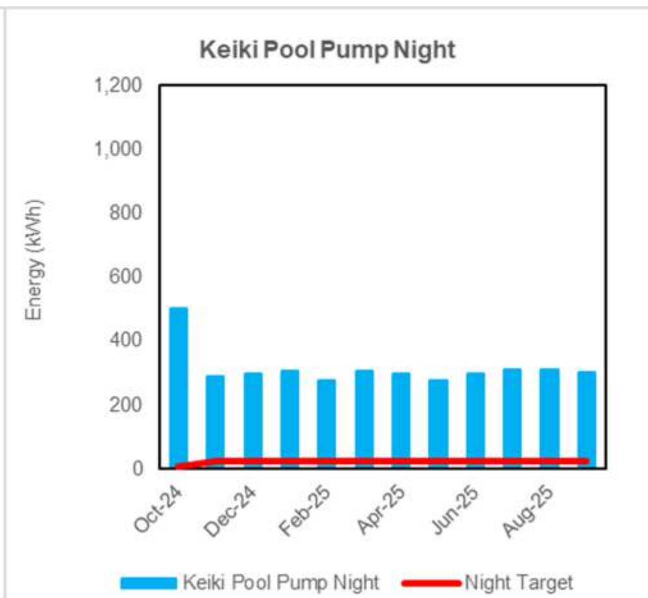
Training Pool Pump Bather
Energy (kWh)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Oct-24
Dec-24
Feb-25
Apr-25
Jun-25
Aug-25
Training Pool Pump Bather
Bather Target



Training Pool Pump Night
Energy (kWh)
2,000
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
Oct-24
Dec-24
Feb-25
Apr-25
Jun-25
Aug-25
Training Pool Pump Night
Night Target



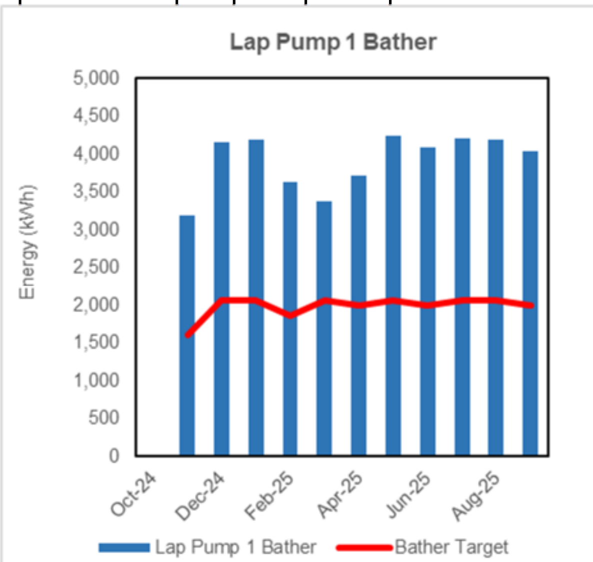
Keiki Pool Pump Bather
Energy (kWh)
1,200
1,000
800
600
400
200
0
Oct-24
Dec-24
Feb-25
Apr-25
Jun-25
Aug-25
Keiki Pool Pump Bather
Bather Target

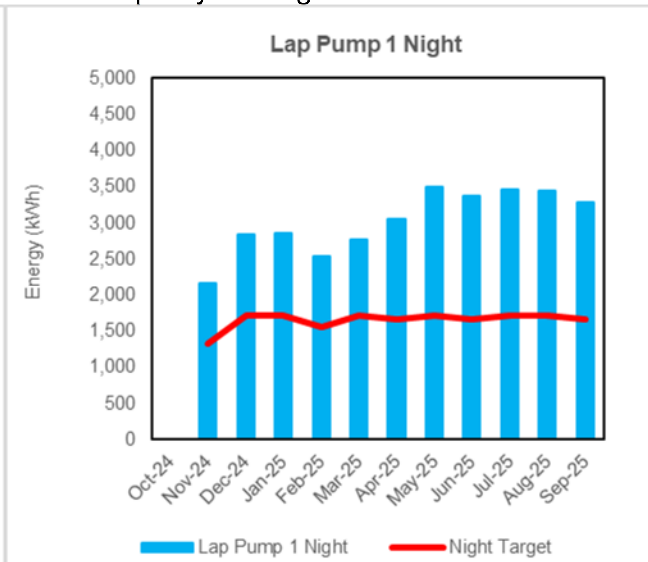


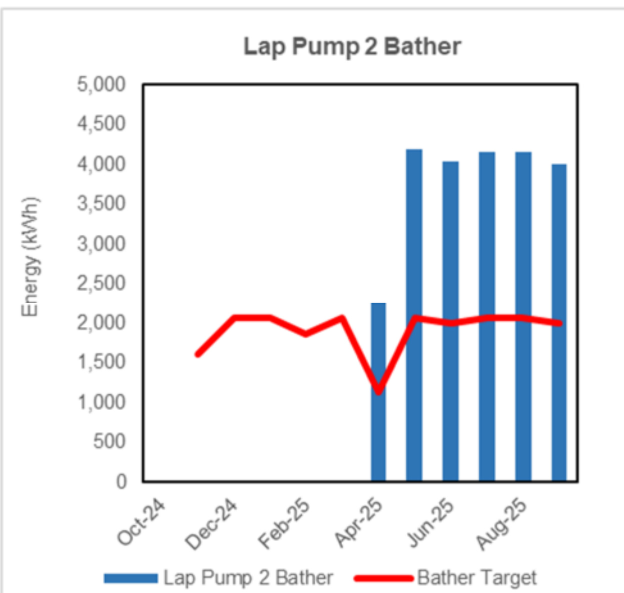
Keiki Pool Pump Night
Energy (kWh)
1,200
1,000
800
600
400
200
0
Oct-24
Dec-24
Feb-25
Apr-25
Jun-25
Aug-25
Keiki Pool Pump Night
Night Target

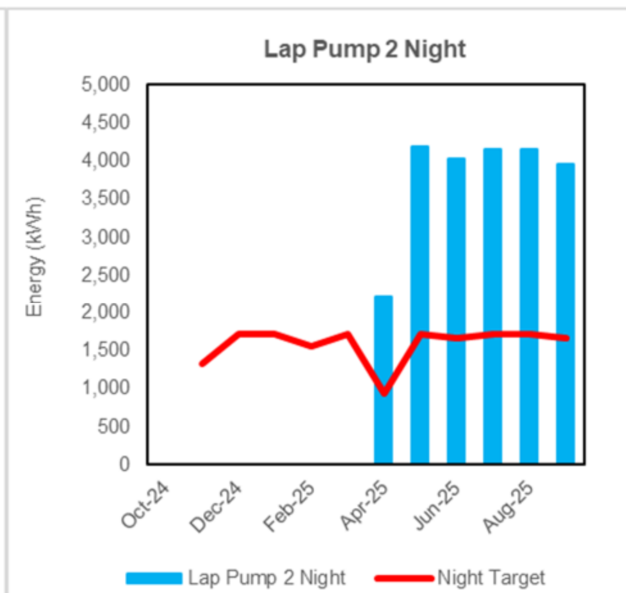
Lahania

Lap pump 1 is operated at lower speeds during night hours. However, there is ongoing work with pump 2 to improve pump control. During Year 1, Maui County and Order of Operations agreed to operate both pumps Lap Pump 1 & 2 to maintain water quality moving forward.



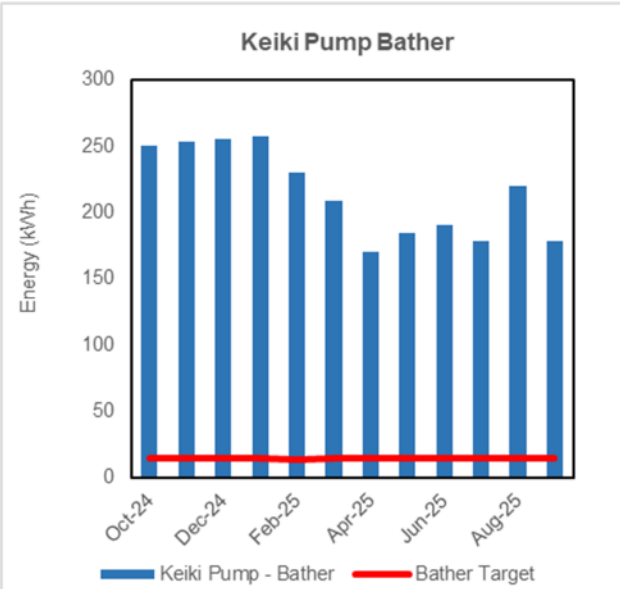


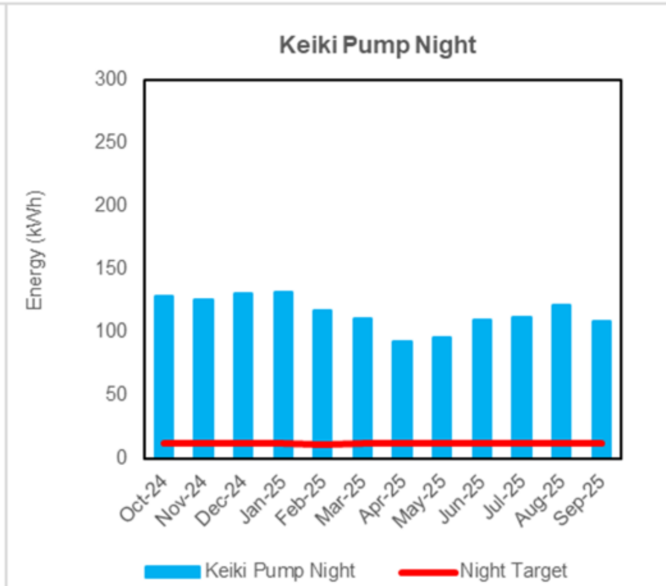


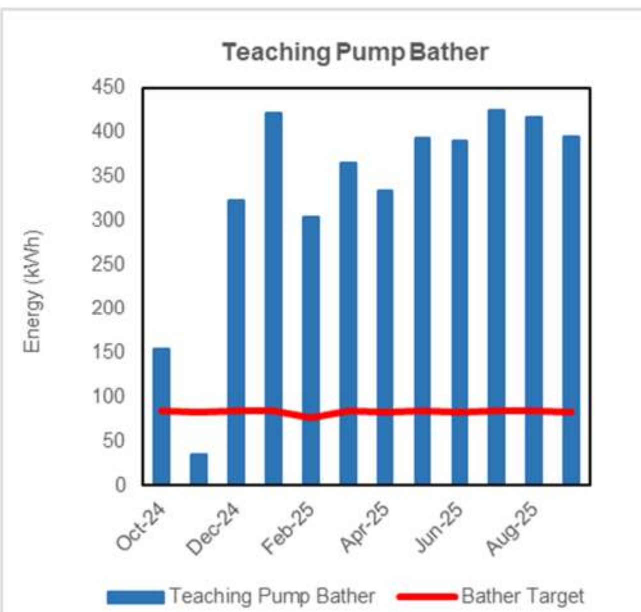


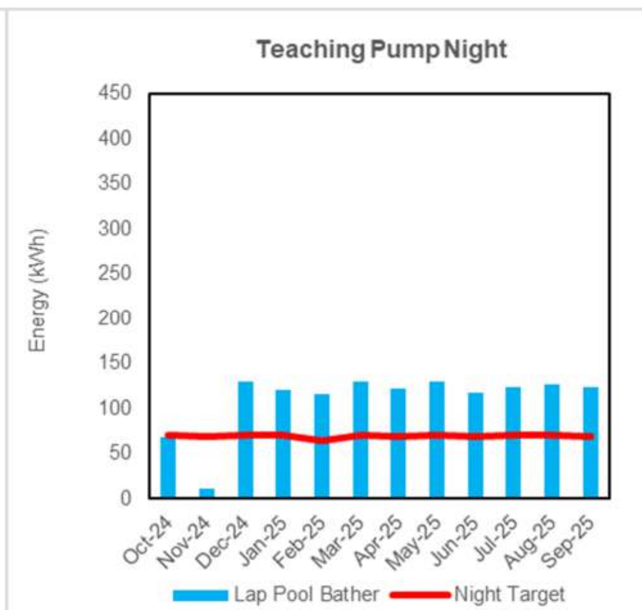
Pukalani

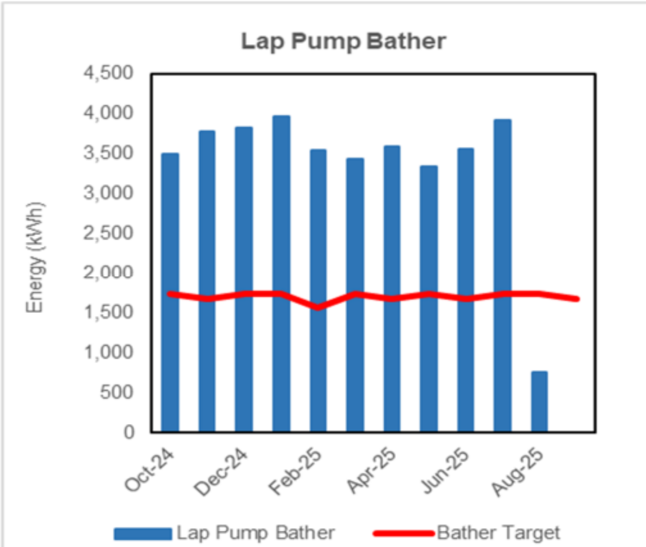
The Keiki and Teaching Pool pumps successfully reduced speeds during unoccupied periods. Work is ongoing to achieve similar reductions for the Lap Pool pump, with JCI actively monitoring progress. In accordance with the agreement with the County of Maui, both Lap Pump 1 and Lap Pump 2 will continue operating under their current schedules in the short term. The long-term strategy is to collaborate with pool maintenance staff to adjust operating schedules to align with projected savings while maintaining water quality standards.

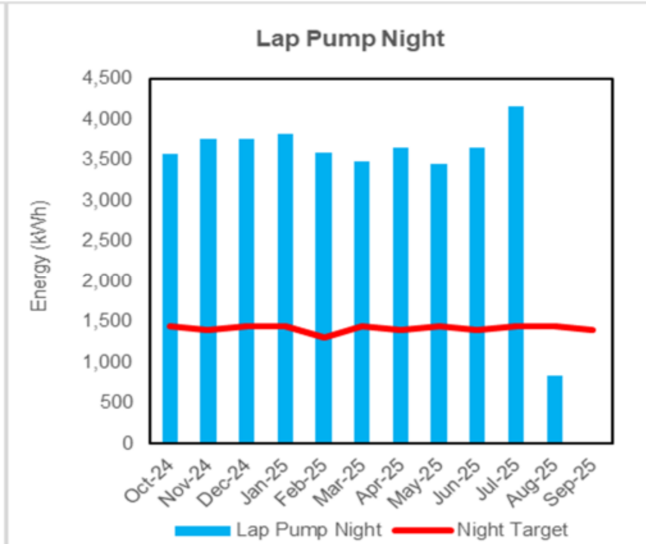




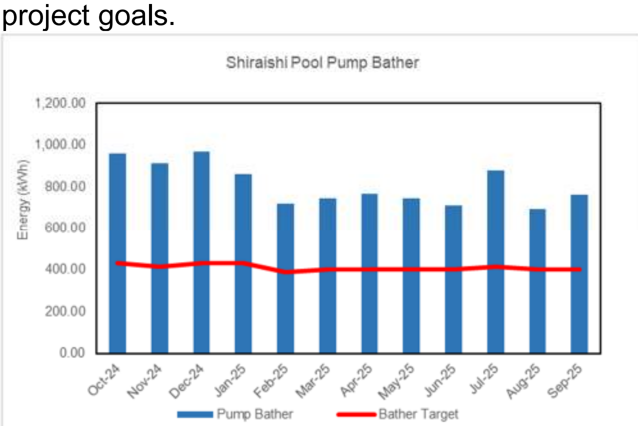


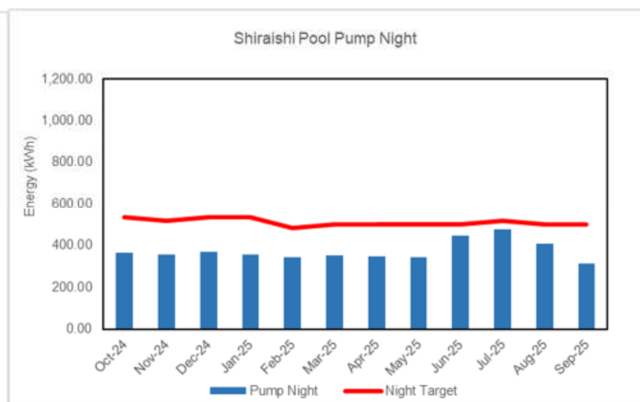




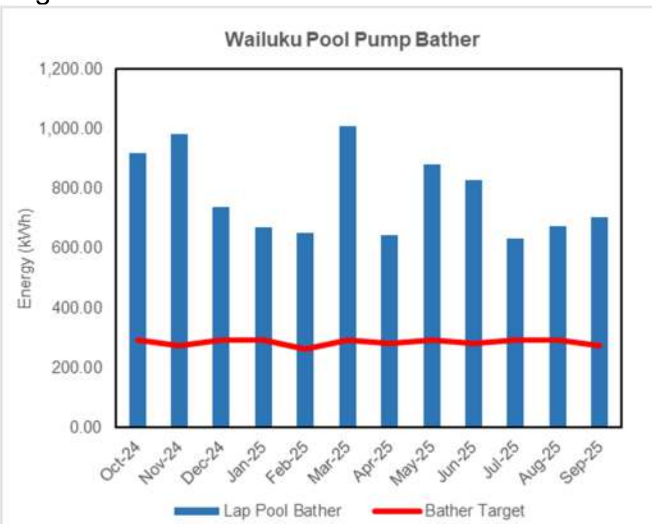


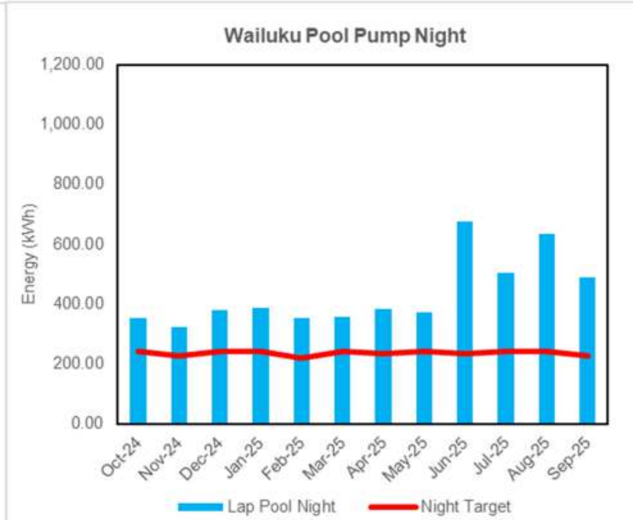
Shiraishi
The pump demonstrated effective speed reduction during unoccupied periods, consistent with project goals.





Wailuku
The pump operated at reduced speeds during unoccupied periods, supporting energy conservation targets.





Verified Savings

Energy savings for FIM 8 are expected to be $78,341 less than anticipated $550,856, per to the revised IGA. This is due to corrected assumptions that ultimately impacted the savings calculations. JCI and Maui County are working jointly to improve operations of the pumps. Some pumps are operating under their current schedules in the short term to ensure water quality standards. The long-term strategy is to collaborate with pool maintenance staff and will focus on improving pool efficiency while maintaining water quality and compliance. Key actions include reviewing VFD profiles for both occupied and unoccupied hours, optimizing pump schedules to match actual occupancy and seasonal patterns, and continuously monitoring energy performance. Findings from these efforts will be shared regularly to ensure transparency, drive ongoing improvements, and deliver measurable savings.

Table 8.1: Onsite Hypochlorite & Smart Pool Pumps Savings Summary

	Electric Savings (kWh)	Electric Cost Savings ($)	Water + Sewer Savings (kGal)	Water + Sewer Savings ($)	O&M Savings	Total Proposed Cost Savings ($)
Proposed Original IGA	859,310	$ 289,607	9,680	$ 48,365	$ 246,672	$ 584,644
Revised IGA	713,458	$ 277,105	9,055	$ 44,326	$ 229,425	$ 550,856
Verified Year 1	488,808	$ 212,721	6,204	$ 30,369	$ 229,425	$ 472,514
Variance (Verified Year 1 - Revised IGA)	(224,650)	$ (64,384)	(2,851)	$ (13,957)	$ -	$ (78,341)

FIM 9: Infiltration Reduction

FIM Description

Existing holes in the building envelope had allowed unconditioned outdoor air to enter the building or conditioned air to escape, which represented an additional load on the air-conditioning system. As a result, infiltration caused unwanted air movement.

While buildings are never completely air-tight and ventilation remains necessary for maintaining healthy indoor environments, there were specific areas of leakage that could be addressed and reduced or eliminated to save energy. Johnson Controls conducted audits for several facilities, identified multiple opportunities to reduce infiltration, and measured the area that could be affected through weatherization to estimate energy savings.

Energy Savings Calculations

Cooling savings achieved from reducing infiltration through weatherization is determined through measured air leakage area and a series of calculations using local weather data.

First, the volumetric rate of air allowed to enter the facility is calculated. Leakage airflow [ft^3/min] is determined from the air leakage area and the wind pressure factor using the equations below:

$$P_t\ [\mathrm{Pa}] = (½ \text{ x } \rho\ [\mathrm{kg/m^3}] \text{ x } (V_t\ [\mathrm{mph}] \text{ x } 1{,}609.344\ [\mathrm{m/mi}]\ /\ 3600\ [\mathrm{sec/hr}]\ )^2)$$

$$\text{Leakage airflow } [\mathrm{lt/sec}] = \Sigma_t [\ P_t\ [\mathrm{Pa}] \text{ x } A\ [\mathrm{m^2}] \text{ x } K\ ]_t$$

$$\text{Leakage airflow } [\mathrm{ft^3/min}] = \text{Leakage airflow } [\mathrm{lt/sec}] \text{ x } 2.1188$$

Cooling Energy Savings is calculated as follows:

$$\text{Clg Energy Savings } [\mathrm{Btu}] = \Sigma_t [\ \text{Leakage } [\mathrm{ft^3/min}] \text{ x } CDD_t\ [°\mathrm{F\text{-}day}] \text{ x } \rho\ [\mathrm{lb/ft^3}] \text{ x } Cp\ [\mathrm{Btu/lb/°F}] \text{ x } 60\ [\mathrm{min/hr}] \text{ x } 24\ [\mathrm{hr/day}] \text{ x } \%AC_t\ ]_t$$

Cooling Energy Savings is converted to electricity savings using the standard conversion value (Btu/kWh) and the coefficient of performance for the facility cooling equipment.

$$\text{Cooling Savings } [\mathrm{kWh}] = \frac{\text{Clg Energy Savings } [\mathrm{Btu}]}{COP_{clg} \text{ x } 3{,}412\ [\mathrm{Btu/kWh}]}$$

where:

- V_t = Average monthly wind speed, obtained from NOAA 30-yr weather data for Kahului, HI. See weather data in table below for monthly average wind speed values used.
- ρ = Density of Air for Kahului, HI = 0.0749 lb/ft3, 1.199 kg/M3 at 70 Degrees
- P_t = Monthly wind pressure factor calculated using the monthly wind speed.
- K = Building factor determining building style, ranging from 95-150. Low K is an efficient building envelope with central mass and high K is open space with many wings. See table below for values used in each site.

A = Air leakage area calculated as linear feet being sealed times Gap width. See table below for values used in each site.

Leakage = Leakage airflow because of the pressure differences caused by wind, stack effect, etc.

CDD_t = Monthly Cooling Degree Days. Estimated for Maui, Hawaii with a balance temperature of 72°F.

Cp = Specific heat of air = 0.243 Btu/lb/°F

$\%AC_t$ = % of building that is air conditioned each month. See table below for values used.

COP_{clg} = Average cooling COP = 3.0

The table below provides details by location for values used in the above equations in addition to count of specific scope items (i.e., Item #1, Exterior Doors) at those locations.

Facility Name	Building K	Total Area (sqft)	% Air Conditioned	(Qty) Ext Doors	(Qty) Interior Doors	(Qty) Window AC Units	(Qty) Pipe Penetrations	(LF) Roof/ Wall Joints	(LF) Seal Windows
Kahului Community Center	95	0.43	100%	5		3			
Kokua Pool	95	2.6	50%	1		1			
Kahului Fire Station	120	2.49	80%	11	11	2	2		
Kahului Wastewater Reclamation Facility	100	0.99	100%	3	3			315	
Kihei Community Center	130	1.56	100%	47					
Kihei Aquatic Center	120	4.88	80%	11					
Kihei Fire Station	100	4.9	60%	3	3	12			
Kihei Police Station	95	0.84	95%	21					
Lahaina Civic Center	140	0.51	85%	32					2
Lahaina Police Station	100	0.65	100%	4		2		262	24
Lahaina Fire Station	120	4.3	100%	1	3				8
Eddie Tam Memorial Center	130	0.71	30%	4		3			
Napili Fire Station	100	0.51	60%	4	2	2			
South Maui Community Center & Park	140	2.71	100%	26					
Wailea Fire Station	120	0.94	60%	3	5				
Wailuku Police Station	100	0.75	85%	5					6
West Maui Senior Center	100	1.88	90%	13					
Fire Prevention Bureau	100	0.94	50%	9					
Forensic Facility	100	0.9	100%	6		5			
Central Landfill	120	1.25	90%	5					
Mayor Hannibal Tavares Community Center	100	0.73	50%	4					
Hoolehua Fire Station	120	0.87	50%	3	2	2			7

Facility Name	Building K	Total Area (sqft)	% Air Conditioned	(Qty) Ext Doors	(Qty) Interior Doors	(Qty) Window AC Units	(Qty) Pipe Penetrations	(LF) Roof/ Wall Joints	(LF) Seal Windows
Sewer Maintenance Building	95	1.04	70%	5	3				1
Kalana O Maui Building	95	1.07	100%	10					
Old Courthouse Building	129	0.69	95%	5					42
Kalana Pakui	100	2.81	100%	15					
Kaunakakai Fire Station	130	0.83	75%	8	6	2			
Kaunoa Senior Services	100	1.31	100%	29		21			
Makawao Baseyard	100	0.73	50%	1	1	2			
Kula Fire Station	130	0.16	70%	1	3				1
Lahaina Wastewater Reclamation Facility	120	3.15	95%	5					8
Lahainaluna Water Treatment Plant	120	0.82	50%	4		1			3
Lanai Baseyard	100	0.69	40%	6		3			
Lanai Fire station	120	0.79	50%	2		3			
Lanai Police Station	100	0.66	95%	6					10
Lanai Public Works	130	0.59	30%	2		2			
Lanai Wastewater Reclamation Facility	95	0.33	50%	1		1			
Piiholo Water Treatment Plant	100	0.52	80%	9					
Olinda Water Treatment Plant	110	0.31	50%	1	1	1			
Makawao Fire Station	100	0.32	70%	3	3				
Mitchel Pauole Community Center	100	0.42	70%	17	3	5			
Molokai Baseyard	130	2.29	40%	2		1			
Paia Fire Station	120	0.32	75%	3	2				
Victims Advocate Building	100	0.21	100%	3					
Waiehu Golf Course	110	0.31	50%	2	1				
Hana Fire Station	100	0.68	70%	3	3				2
Hana Police Station	95	1.32	90%	3		3		142	
Kahului Baseyard	120	6.25	100%	6	4	6			10
Mahinahina Water Treatment Plant	110	0.17	50%	4	1				
Iao Water Treatment Plant	130	0.83	40%	4	2				
TOTAL		**65.96**		**381**	**62**	**83**	**2**	**719**	**124**

Calculated savings have been decreased by 20% to account for uncertainties.

The table below provides the monthly weather data for Kahului Airport and some calculated values that are consistent for all facilities affected by this FIM.

	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Average Wind (MPH	9.40	10.10	11.20	11.60	11.50	12.60	13.10	12.80	11.20	10.40	10.50	10.10
CDD	527.0	476.0	567.3	588.0	657.2	705.0	768.8	799.8	765.0	750.2	651.0	582.8
Wind (L/S) Calculated	4.20	4.52	5.01	5.19	5.14	5.63	5.86	5.72	5.01	4.65	4.69	4.52
Pd (Pa) Calculated	10.59	12.22	15.03	16.12	15.84	19.02	20.56	19.63	15.03	12.96	13.21	12.22

Measurement and Verification

Operational Verification (OV) Approach:
OV approach provides verification of a system's capability to produce the projected energy savings.

Detailed M&V isn't cost effective for the On-Site Hypochlorite Generation and Infiltration Reduction due to the relatively small amount of energy savings attributed to these FIMs. Post-installation M&V will consist of verifying installation of the FIMs as outlined below.

FIM	Frequency	Task Description
Irrigation System	One Time – Post Installation	*Post Installation* • Visually verify and document via digital photographs the operation of the irrigation controller.
On-Site Hypochlorite Generation	One Time – Post installation	See *Energy Savings Calculations* section in the *FIM Descriptions* *Post Installation* • Onsite chlorine generator (Verify nameplate data). • Visually verify and document salt use to generate chlorine. Review the functional testing documents associated with the installation.
Infiltration Reduction	One Time – Post installation	*Post Installation* • Visually verify and document via digital photographs the areas affected by the envelope improvements. Review the pre and post leakage area (sqft).

Performance Verification

This FIM is part of a one-time assessment carried out during the installation phase; accordingly, measurement and verification activities were not performed during the Year 1 performance period. The appendix contains the counts of doors, windows, and other wall penetrations that were sealed details can be found in Appendix B – FIM 9 – Closeout Document.

Verified Savings

For this FIM 9, the additional savings of $7,087 are attributed to as-found conditions at the project site, at the time of installation. Many of the spots or areas that are to be sealed were found to be slightly longer or larger than what was originally anticipated. As such, with longer or bigger area being sealed, baseline energy usage (energy loss) was adjusted, resulting in decreased post-install energy and increase energy savings.

Table 9.1: Infiltration Reduction Savings Summary

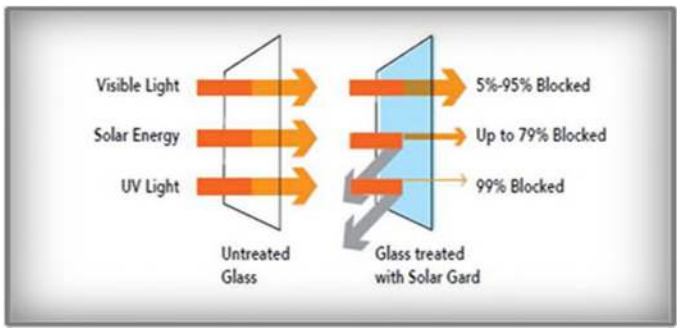
	Electric Savings (kWh)	Electric Cost Savings ($)	Total Proposed Cost Savings ($)
Proposed Original IGA	-	$ -	$ -
Revised IGA	275,883	$ 107,594	$ 107,594
Verified Year 1	293,624	$ 114,681	$ 114,681
Variance (Verified Year 1 - Revised IGA)	17,741	$ 7,087	$ 7,087

FIM 10: Window Film

FIM Description

There are a variety of different films that can be applied to most windows. They vary in reflectivity and visible light transmittance. Typically, the darker the film, the more solar heat gain reduction and the better the savings. Alternatively, some films are quite clear, and they can be applied without altering the look of the windows. Most films are installed on the inside of the window, and do not affect the warranty of the window and avoid weathering issues.

The figure below schematically represents the benefits of window film:



Johnson Controls has experience installing window film for several customers in Hawaii. From that experience, we have seen great results with ceramic-based and hybrid window films, with slight tints to reduce UV and heat gain without darkening the windows any noticeable amount.

The scope of work for this FIM includes materials and labor for the installation of new window film to the interior glass of certain areas and buildings to reject and reflect a portion of the solar radiation and reduce the cooling load of the spaces. These spaces either have window film that has failed or nothing at all.

Energy Savings Calculations

Window Film Retrofit Energy Savings

Electrical savings are generated through a reduction in cooling load due to the reduction in solar heat gain through windows because of the installation of window film. The solar heat gains from windows savings are directly proportional to the glass areas where window film is installed.

Equations for Calculating Window Film Savings

$$kWh_{Savings} = \frac{(1 - Shading\ Coeff) * Window\ Area * Annual\ Insolation * \left(SHGC_{pre} - SHGC_{post}\right) / \frac{ft2}{m2}}{COP}$$

Where:

$kWh_{Savings}$ = Annual power savings from the implementation of window film

$Shading\ Coeff$ = Shading Coefficient for existing glass without window film as published by ASHRAE

$Window\ Area$ = Measured area of window in square feet

$Annual\ Insolation$ = Annual Insolation (kWh/m^2) - sun exposure as determined from NREL TMY3 weather data

$SHGC_{pre}$ = Solar Heat Gain Coefficient for existing window before installation (*pre*)

$SHGC_{post}$ = Solar Heat Gain Coefficient for window with the window film (*post*)

$\frac{ft2}{m2}$ = unit conversion = 10.7584

COP = Coefficient of performance for air conditioning equipment

Annual energy cost savings are determined by multiplying the kWh energy savings by the corresponding facility energy rate ($/kWh).

The table below provides the audited values for input into the savings calculations for the buildings where this FIM is being applied. There is a line-item calculation for each window type, orientation, and varying shading coefficients at the facility.

Building	COP	Glass Type	Direction	Insolation (kwh/m^2)	Window Qty	Window Sq-Ft	Shading Coefficent	SHGC - Pre	SHGC - Post
Totals					**204**	**2,444**			
Kihei Community Center	3	Double Pane - Clear	North	515	10	227	0.75	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	North	515	12	178	0.10	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	North	515	10	117	0.75	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	North	515	12	120	0.75	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	North	515	6	79	0.75	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	South	1,339	9	204	0.75	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	South	1,339	12	178	0.10	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	South	1,339	9	105	0.75	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	South	1,339	16	160	0.75	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	South	1,339	8	106	0.75	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	East	1,030	2	63	0.75	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	East	1,030	7	99	0.45	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	East	1,030	4	53	0.45	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	West	1,030	2	14	0.75	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	West	1,030	10	132	0.75	0.76	0.20
Kihei Community Center	3	Double Pane - Clear	West	1,030	7	93	0.75	0.76	0.20
Paia Fire Station	3	Double Pane - Clear	North	515	12	83	0.05	0.76	0.20
Paia Fire Station	3	Double Pane - Clear	East	1,030	16	110	0.05	0.76	0.20
Paia Fire Station	3	Double Pane - Clear	South	1,339	12	83	0.05	0.76	0.20
Kula Fire Station	3	Single Pane - Clear	North	515	4	51	0.05	0.86	0.20
Kula Fire Station	3	Single Pane - Clear	North	515	2	17	0.10	0.86	0.20
Kula Fire Station	3	Single Pane - Clear	North	515	4	16	0.10	0.86	0.20
Kula Fire Station	3	Single Pane - Clear	North	515	2	13	0.10	0.86	0.20
Kula Fire Station	3	Single Pane - Clear	North	515	2	24	0.10	0.86	0.20
Kula Fire Station	3	Single Pane - Clear	North	515	2	25	0.10	0.86	0.20
Kula Fire Station	3	Single Pane - Clear	South	1,339	2	8	0.20	0.86	0.20
Kula Fire Station	3	Single Pane - Clear	West	1,030	4	50	0.10	0.86	0.20
Kula Fire Station	3	Single Pane - Clear	West	1,030	2	18	0.10	0.86	0.20
Kula Fire Station	3	Single Pane - Clear	East	1,030	2	4	0.20	0.86	0.20
Kula Fire Station	3	Double Pane - Clear	East	1,030	1	6	0.55	0.76	0.20
Kula Fire Station	3	Single Pane - Clear	East	1,030	1	11	0.30	0.86	0.20

Measurement and Verification

The savings for this FIM will be verified using IPMVP-2016 Option A, Retrofit Isolation with Key Parameter Measurement. The savings for this FIM are generated through the installation of window film which reduces the cooling load of space; therefore, the measurement boundary is the glass area where the window film is installed.

Key Parameter	Measurement Frequency	Measurement Description
Post Installation Window Area	Short-Term	Actual glass area (sq ft) where window film is installed
Estimated Parameters	**Assumed Value**	**Justification, Source and Description**
Solar Heat Gain	See *Energy Savings Calculations* section in the *FIM Descriptions*	Values obtained from ASHRAE and adjusted for the building hours/days of operation and will not be measured.
SHGCpre	See *Energy Savings Calculations* section in the *FIM Descriptions*	Values obtained from ASHRAE for the existing glass types observed during site surveys and will not be measured.
SHGCpost	See *Energy Savings Calculations* section in the *FIM Descriptions*	Values obtained from window film manufacturer based on the proposed window film for the existing glass types observed during site surveys and will not be measured.
Cooling kW/ton	See *Energy Savings Calculations* section in the *FIM Descriptions*	Values estimated for the type and age of equipment providing the cooling and will not be measured.

Performance Verification

A one-time evaluation confirmed installation of 3,057 square feet of window film across multiple sites. No Year 1 M&V activities were performed. Scope adjustments during construction resulted in a net reduction of 98 square feet. The final installed window film totaled 3,057 square feet after scope adjustments.

Site	North	East	South	West	Total
Kihei Community Center	762	-	953	88	1,803
South Maui District Office	-	66	33	190	289
Satellite Office DMV	40	188	40	167	435
Kuoha Business	-	-	-	-	-
Lanai Baseyard	-	-	-	-	-
Paia Fire Station	114	105	86	43	348
Kula Fire Station	154	-	27	99	280
Total	1,070	359	1,139	587	**3,155**

During construction, scope changes resulted in a net increase of 620 square feet. The breakdown is shown below:

Site	North	East	South	West	Total
Kihei Community Center	41	(215)	200	(150)	(124)
South Maui District Office	-	66	33	190	289
Satellite Office DMV	40	188	40	167	435
Kuoha Business	(10)	-	-	(34)	(43)
Lanai Baseyard	-	(48)	-	-	(48)
Paia Fire Station	31	(5)	3	43	72
Kula Fire Station	9	(20)	19	32	39
Total	112	(35)	295	248	620

Verified Savings

During the installation of FIM 9, Johnson Controls identified additional window surfaces and proceeded to implement Window Film improvements. This resulted in an additional $2,558 in savings with no increase in project costs. The cost savings are calculated according to the rates applicable in Year 1.

Table 10.1: Window Film Savings Summary

	Electric Savings (kWh)	Electric Cost Savings ($)	Total Proposed Cost Savings ($)
Proposed Original IGA	**20,469**	**$ 8,190**	**$ 8,190**
Revised IGA	**19,067**	**$ 7,552**	**$ 7,552**
Verified Year 1	**25,321**	**$ 10,111**	**$ 10,111**
Variance (Verified Year 1 - Revised IGA)	**6,254**	**$ 2,558**	**$ 2,558**

Appendix

A. FIM 4.0 – Transformer Replacements:
   Power Measurements

B. FIM 9.0 - Infiltration Reduction:
   Closeout Documents

MEASUREMENT & VERIFICATION SERVICES

JCI will provide the M&V Services set forth below in connection with the Performance Assurance Agreement.

- During the Installation Period, a JCI Performance Assurance Specialist will track Measured Project Benefits. JCI will report the Measured Project Benefits achieved during the Installation Period, as well as any Non-Measured Project Benefits applicable to the Installation Period, to Customer within 60 days of the commencement of the Guarantee Term.

- Within 60 days of each anniversary of the commencement of the Guarantee Term, JCI will provide Customer with an annual report containing:

  - an executive overview of the project's performance and Project Benefits achieved to date;
  - a summary analysis of the Measured Project Benefits accounting; and
  - depending on the M&V Option, a detailed analysis of the Measured Project Benefits calculations.

- During the Guarantee Term, a JCI Performance Assurance Specialist will monitor the on-going performance of the Improvement Measures, as specified in this Agreement, to determine whether anticipated Measured Project Benefits are being achieved. In this regard, on a quarterly basis, the Performance Assurance Specialist will provide observations and recommendations regarding system performance based upon a review of operating parameters, contingent upon Customer providing JCI with remote access to the systems included in this Agreement, with respect to the following activities:

  - review of information furnished by Customer from the facility management system to confirm that control strategies are in place and functioning;
  - advise Customer's designated personnel of any performance deficiencies based on such information;
  - coordinate with Customer's designated personnel to address any performance deficiencies that affect the realization of Measured Project Benefits; and
  - inform Customer of opportunities to further enhance project performance and of opportunities for the implementation of additional Improvement Measures.

- For specified Improvement Measures utilizing an "Option A" M&V protocol, JCI will:

  - conduct post installation measurements required under this Agreement;
  - confirm the building management system employs the control strategies and set points specified in this Agreement; and
  - analyze actual as-built information and adjust the Baseline and/or Measured Project Benefits to conform to actual installation conditions (e.g., final lighting and water benefits calculations will be determined from the as-built information to reflect the actual mix of retrofits encountered during installation).
  - Trend data records maintained in the ordinary course of system operation shall be used and relied upon by Johnson Controls in connection with Project Benefit calculations. Johnson Controls will use commercially reasonable efforts to ensure the integrity of the data collected to calculate the required metrics. In the event data are lost due to equipment failure, power failure or other interruption in data collection, transmission or storage, Johnson Controls will use reasonable engineering methods to estimate the impact of or replace the lost data

- Energy Star
  - Johnson Controls to provide assistance with annual update of Customer Energy Star Portfolio Manager, for buildings over 10,000 square feet which are also an eligible building type to qualify for an Energy Star score.

- Johnson Controls to provide trending software to be used for data collection and reporting purposes.
  - JCI trending software is being furnished with this project as an interface program between the new Building Automation Systems and the ongoing monitoring tasks of JCI's Performance Specialist. This trending package is not specific to JCI Metasys and will work with many other Building Automation Systems.
  - In order to properly implement the system, the Customer will either allow JCI to install GoToAssist remote access software or provide JCI with remote access with administrator rights on the virtual machine. The Customer will also provide administrator rights for SQL to configure the JCI Performance Software database.

POWERSMITHS
Socomec Group

Transformer Measurement & Verification Report

Project:

Maui County – Phase 1

Prepared for:

Johnson Controls

Powersmiths International Corp.
November 15, 2023

TABLE OF CONTENTS

M&V Methodology

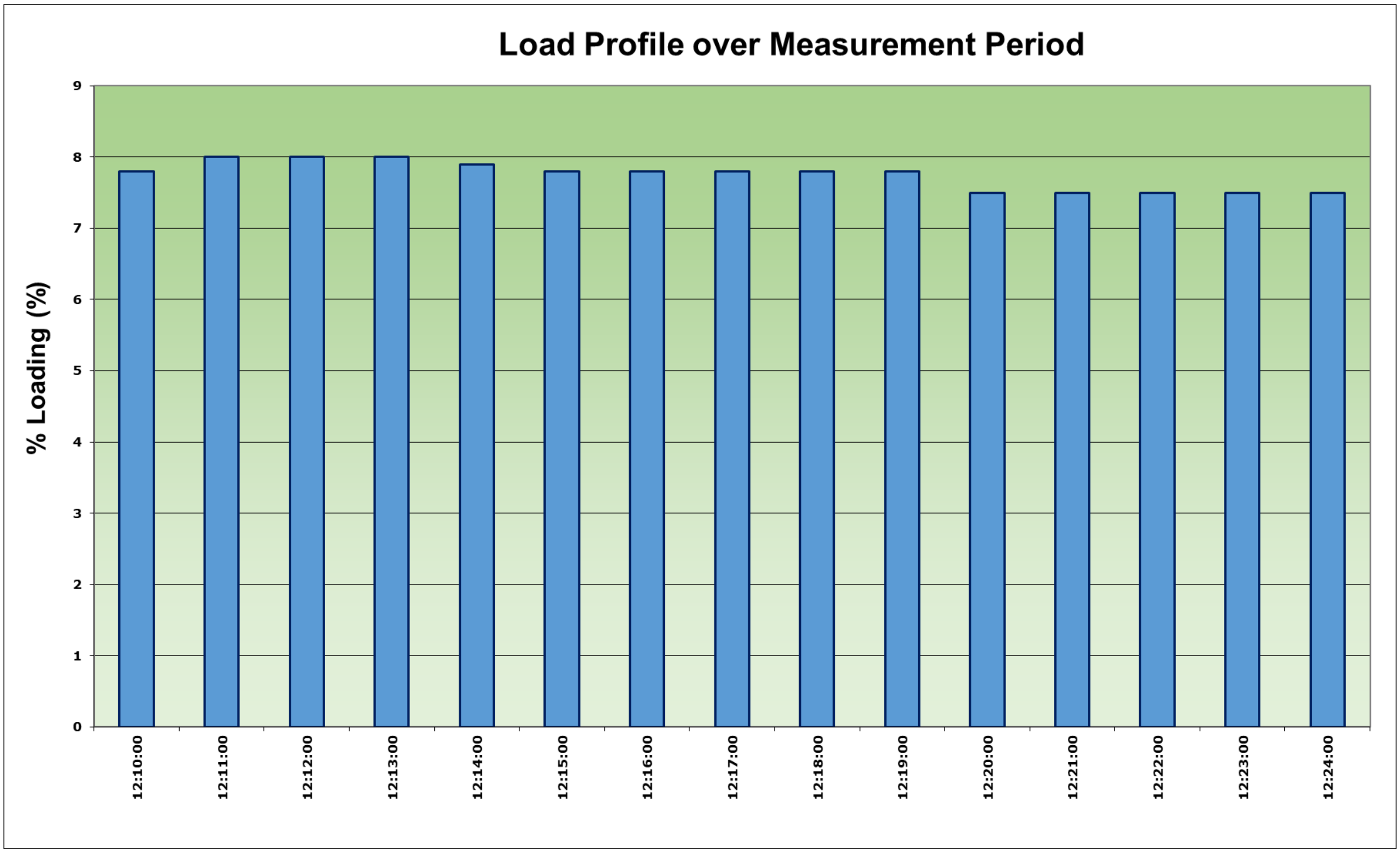
ECM Technology Category	Parameter Type	Parameter	Project Phase	
			Baseline	Post-Installation
Transformer Retrofits	Performance	Transformer Loading & Losses	One-time measurement of representative transformer loading & losses	One-time measurement of representative transformer loading & losses
	Operational	Annual operating hours & times	Based on interview data	ISO 17025 Certified Efficiency Test Lab Validation using baseline load profile

Transformer Measurement Summary

Baseline measurements were taken on ten (10) existing transformers using the Cyberhawk EP-300 portable meter. The measured loading and losses of the replacement Powersmiths E-Saver transformers were measured in the Powersmiths ISO 17025 Certified Test Lab and compared to the old transformers (see tables below for each transformer). **The average reduction in Average Losses with Powersmiths E-Saver Transformer is 76.4%**

Transformer Measurement Tables and Charts

Transformer Measurement Table		
Building	Olinda WTP	
Location	Main Electrical Room	
Tag Number	56220	
kVA	30	
	Baseline	Powersmiths
Measurement Period (HH:MM)	00:15	ISO 17025 Certified Test Lab
Sample Interval	1 Minute	
Manufacturer	GE	Powersmiths
Model	9T23B3872	E-Saver 80R
% Loading – Average	7.7%	8.1%
Losses (kW) – Average	0.477	0.062
Reduction in Average Losses		87.1%


Load Profile over Measurement Period
% Loading (%)
0
1
2
3
4
5
6
7
8
9
12:10:00
12:11:00
12:12:00
12:13:00
12:14:00
12:15:00
12:16:00
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12:18:00
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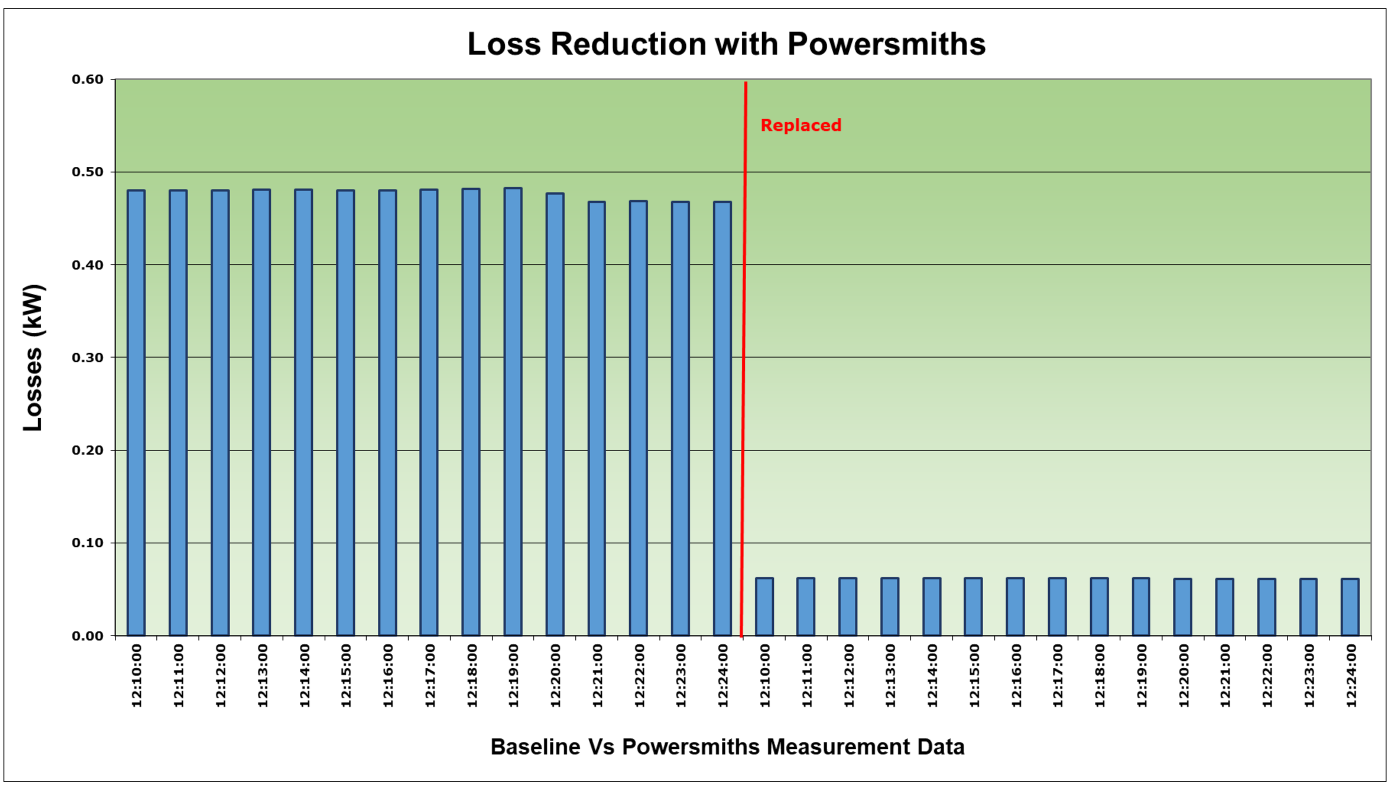
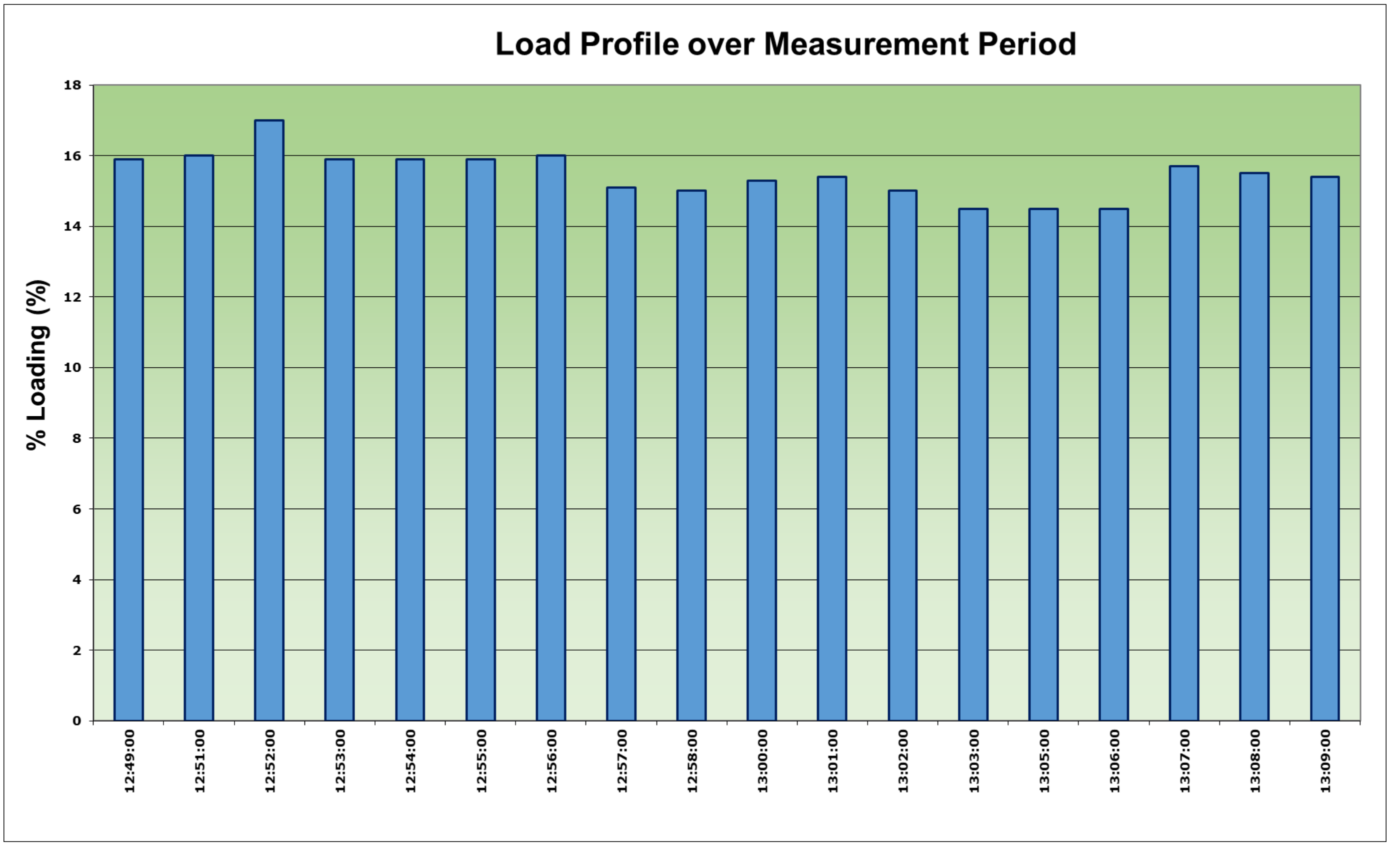
12:23:00
12:24:00


Loss Reduction with Powersmiths
Losses (kW)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
Replaced
12:10:00
12:11:00
12:12:00
12:13:00
12:14:00
12:15:00
12:16:00
12:17:00
12:18:00
12:19:00
12:20:00
12:21:00
12:22:00
12:23:00
12:24:00
12:10:00
12:11:00
12:12:00
12:13:00
12:14:00
12:15:00
12:16:00
12:17:00
12:18:00
12:19:00
12:20:00
12:21:00
12:22:00
12:23:00
12:24:00
Baseline Vs Powersmiths Measurement Data

Transformer Measurement Table		
Building	**Olinda WTP**	
Location	**Electrical Room by Gen**	
Tag Number	**56221**	
kVA	**30**	
	Baseline	**Powersmiths**
Measurement Period (HH:MM)	**00:18**	**ISO 17025 Certified Test Lab**
Sample Interval	**1 Minute**	
Manufacturer	**Challenger**	**Powersmiths**
Model	**302-415B-MOD.5**	**E-Saver 80R**
% Loading – Average	**15.5%**	**16.9%**
Losses (kW) – Average	**0.491**	**0.086**
Reduction in Average Losses		**82.5%**


Load Profile over Measurement Period
% Loading (%)
18
16
14
12
10
8
6
4
2
0
12:49:00
12:51:00
12:52:00
12:53:00
12:54:00
12:55:00
12:56:00
12:57:00
12:58:00
13:00:00
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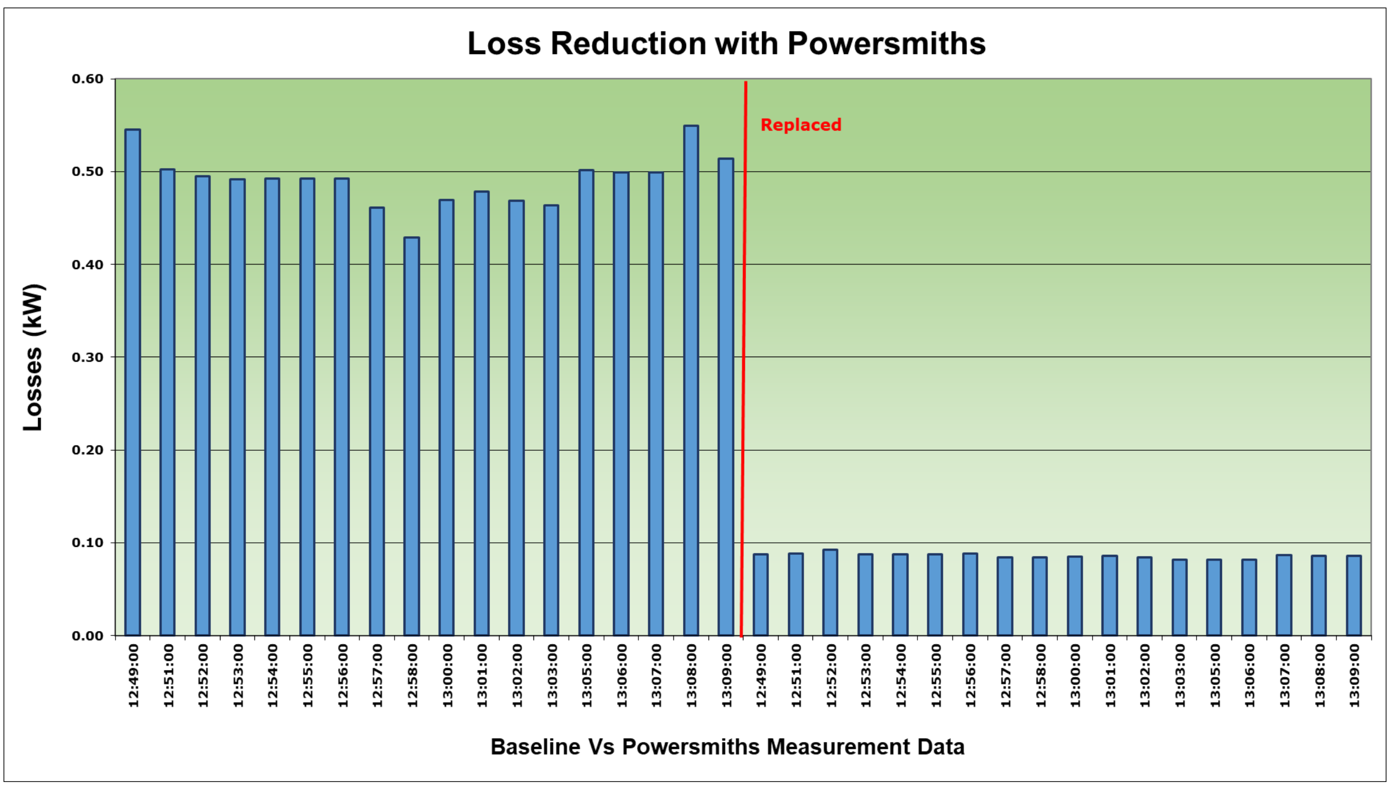
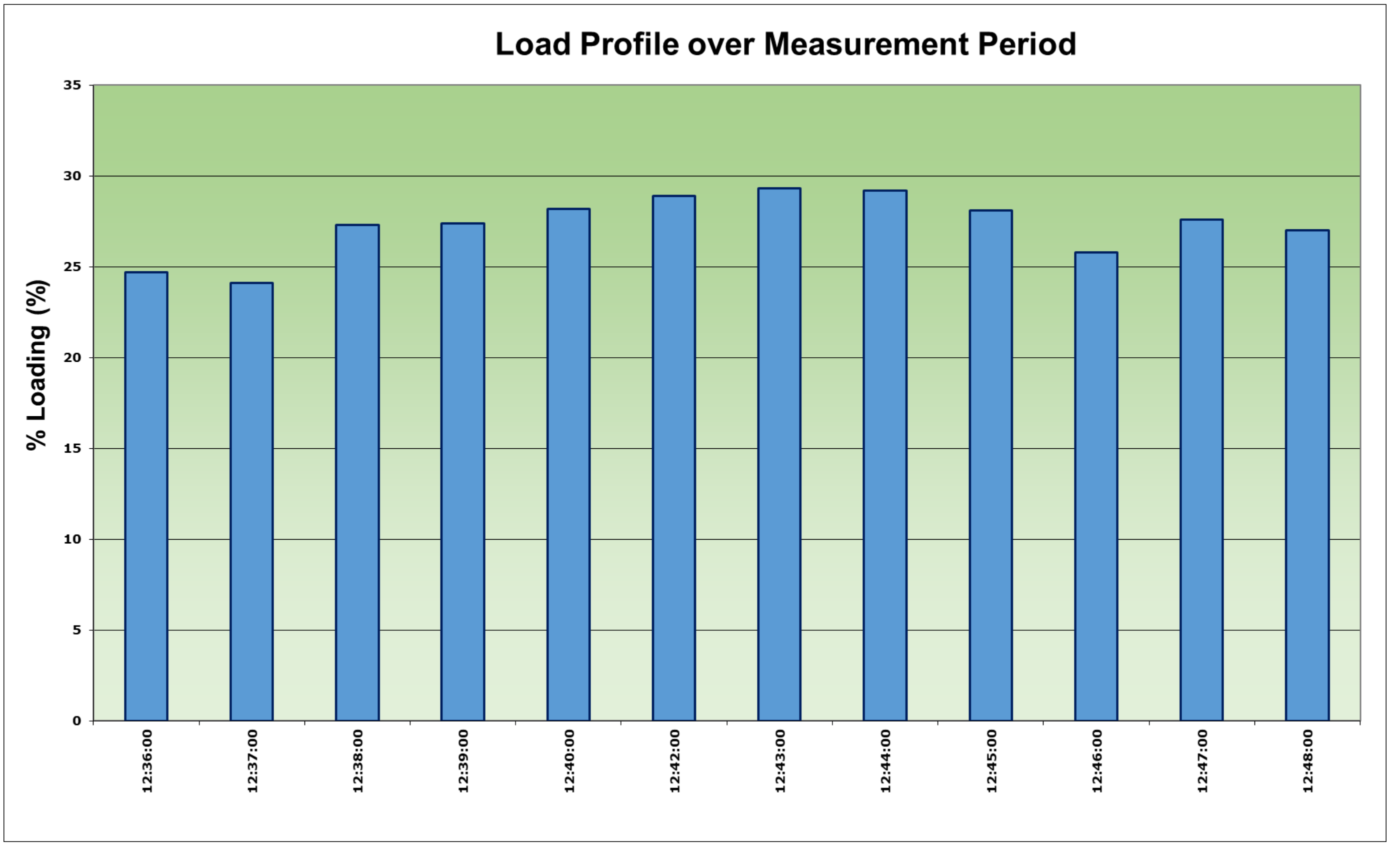
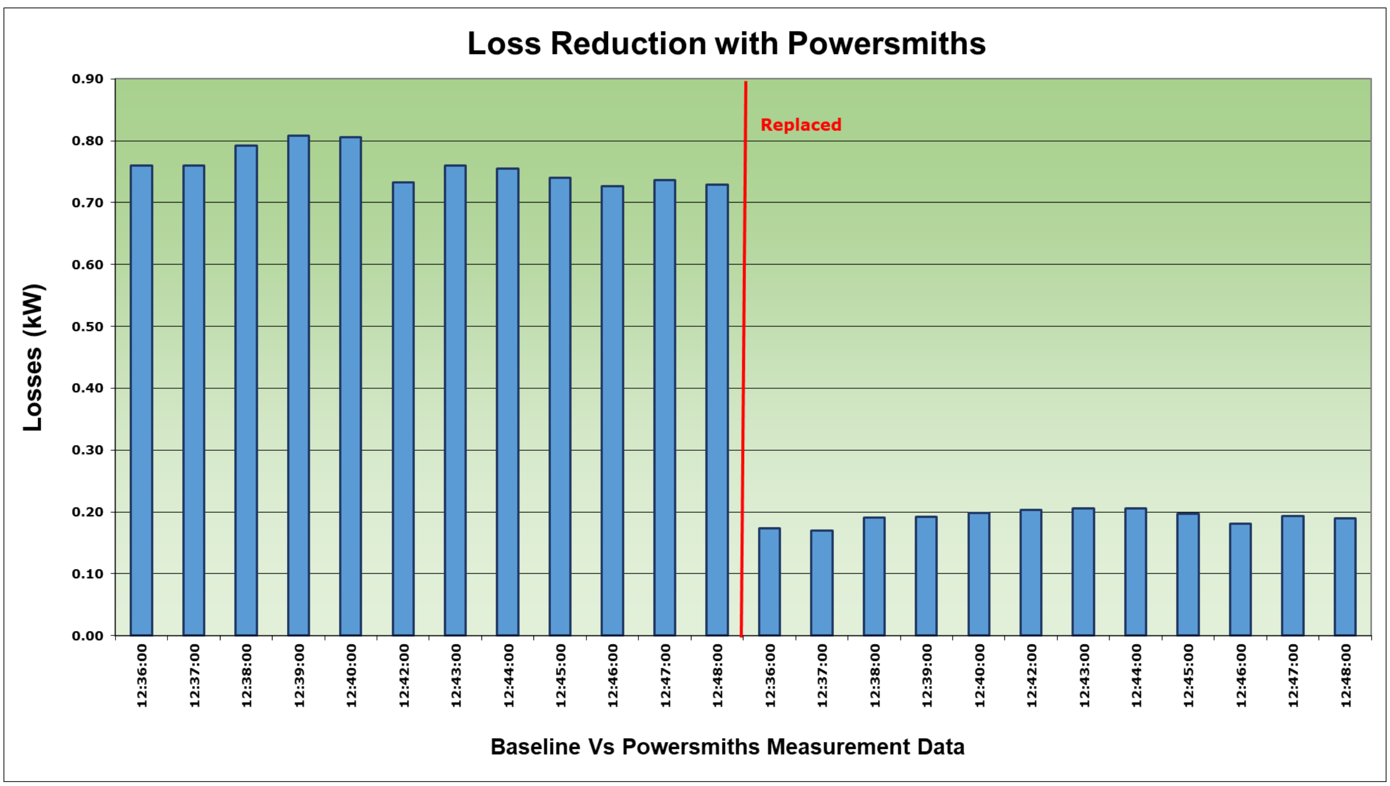
13:02:00
13:03:00
13:05:00
13:06:00
13:07:00
13:08:00
13:09:00

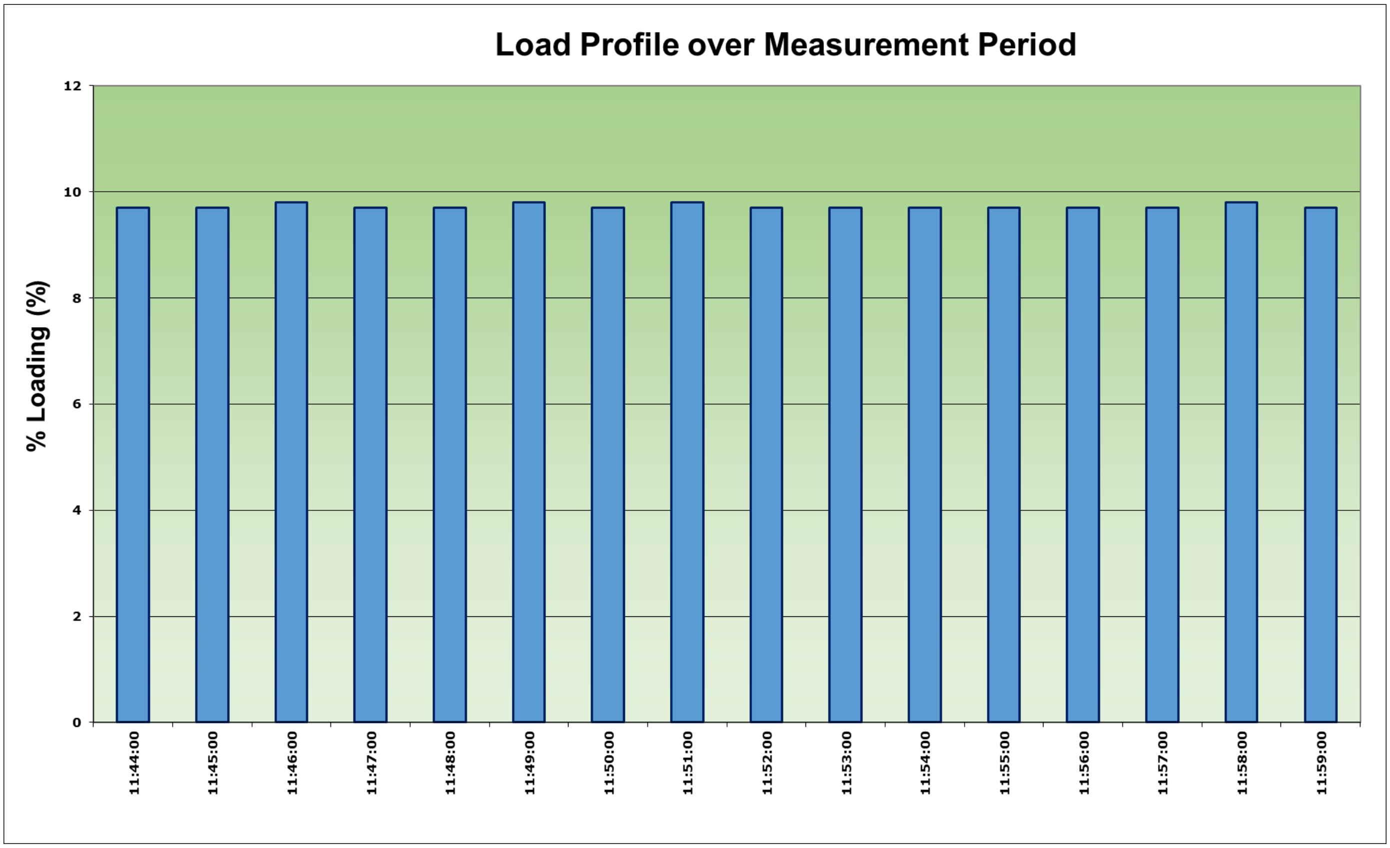

Loss Reduction with Powersmiths
Losses (kW)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Replaced
12:49:00
12:51:00
12:52:00
12:53:00
12:54:00
12:55:00
12:56:00
12:57:00
12:58:00
13:00:00
13:01:00
13:02:00
13:03:00
13:05:00
13:06:00
13:07:00
13:08:00
13:09:00
Baseline Vs Powersmiths Measurement Data

Transformer Measurement Table		
Building	**Kahului Baseyard**	
Location	**Telemetry Bldg Elec Room**	
Tag Number	**56217**	
kVA	**45**	
	Baseline	**Powersmiths**
Measurement Period (HH:MM)	**00:12**	**ISO 17025 Certified Test Lab**
Sample Interval	**1 Minute**	
Manufacturer	**Hevi-Duty**	**Powersmiths**
Model	**T2HB45**	**E-Saver 2016**
% Loading – Average	**27.3%**	**28.0%**
Losses (kW) – Average	**0.759**	**0.192**
Reduction in Average Losses		**74.7%**


Load Profile over Measurement Period
% Loading (%)
35
30
25
20
15
10
5
0
12:36:00
12:37:00
12:38:00
12:39:00
12:40:00
12:42:00
12:43:00
12:44:00
12:45:00
12:46:00
12:47:00
12:48:00


Loss Reduction with Powersmiths
Losses (kW)
Replaced
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
12:36:00
12:37:00
12:38:00
12:39:00
12:40:00
12:42:00
12:43:00
12:44:00
12:45:00
12:46:00
12:47:00
12:48:00
12:36:00
12:37:00
12:38:00
12:39:00
12:40:00
12:42:00
12:43:00
12:44:00
12:45:00
12:46:00
12:47:00
12:48:00
Baseline Vs Powersmiths Measurement Data

Transformer Measurement Table		
Building	Kihei WWTP	
Location	Dewatering Bldg Elec Room	
Tag Number	56225	
kVA	45	
	Baseline	Powersmiths
Measurement Period (HH:MM)	00:16	ISO 17025 Certified Test Lab
Sample Interval	1 Minute	
Manufacturer	Square D	Powersmiths
Model	45T3HB	E-Saver 80R
% Loading – Average	9.7%	10.3%
Losses (kW) – Average	0.676	0.090
Reduction in Average Losses		86.6%


Load Profile over Measurement Period
% Loading (%)
0
2
4
6
8
10
12
11:44:00
11:45:00
11:46:00
11:47:00
11:48:00
11:49:00
11:50:00
11:51:00
11:52:00
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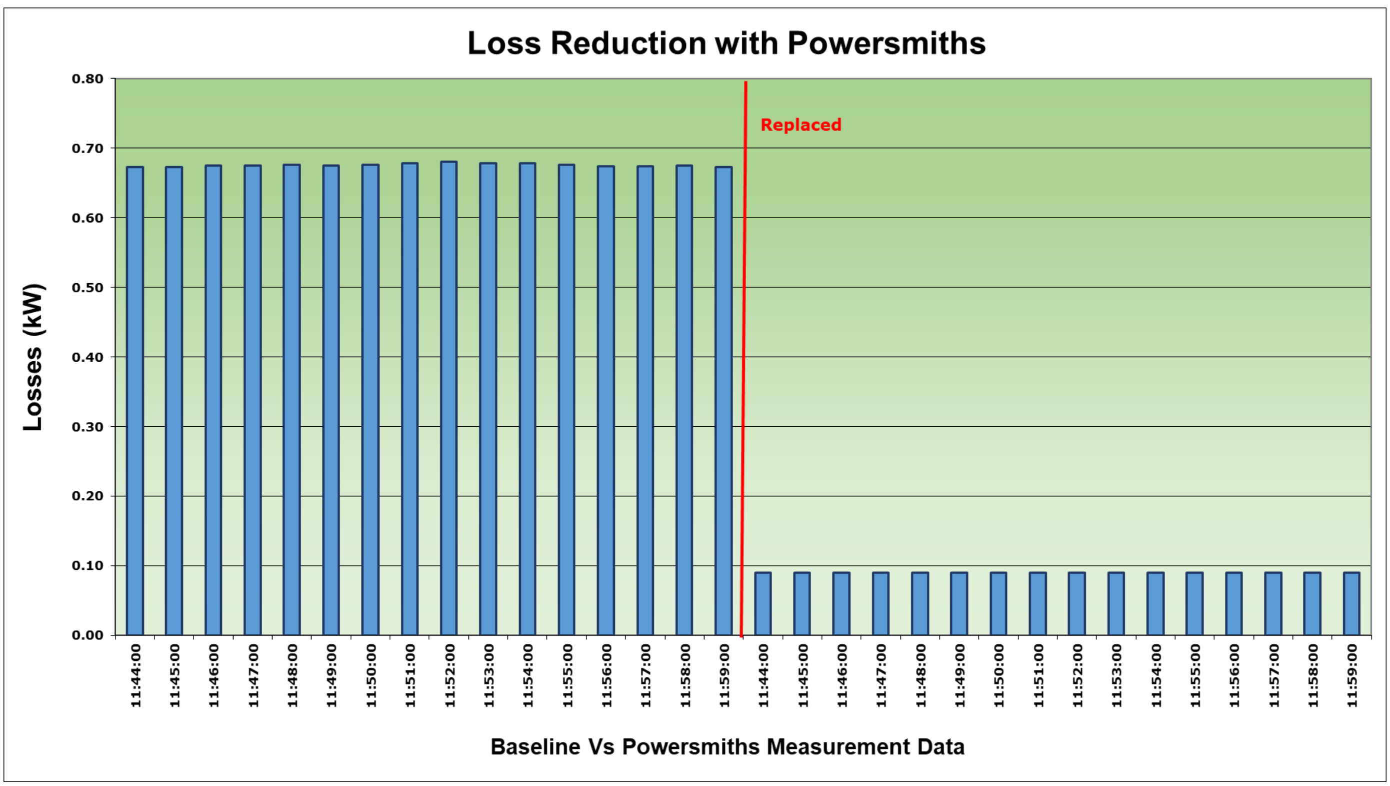
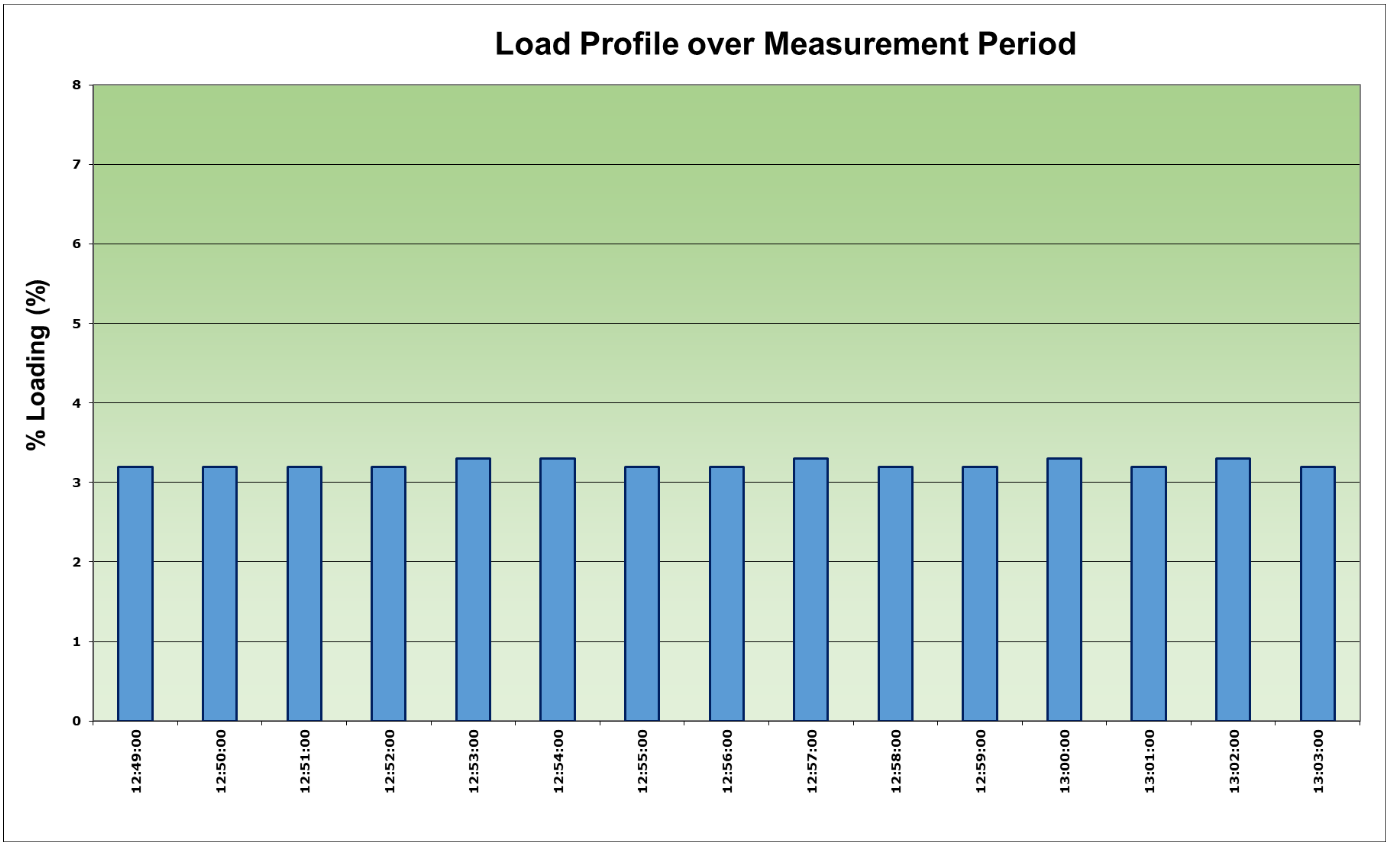
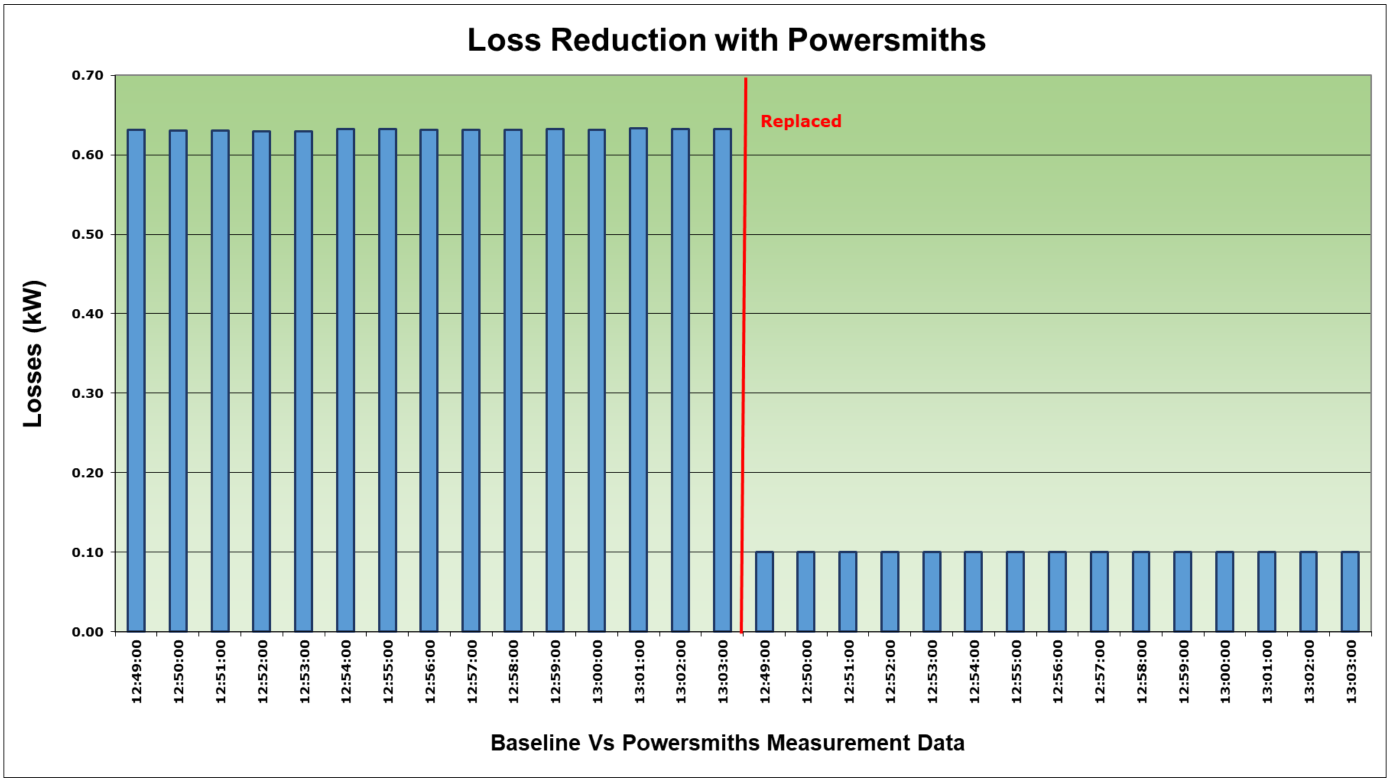
11:57:00
11:58:00
11:59:00

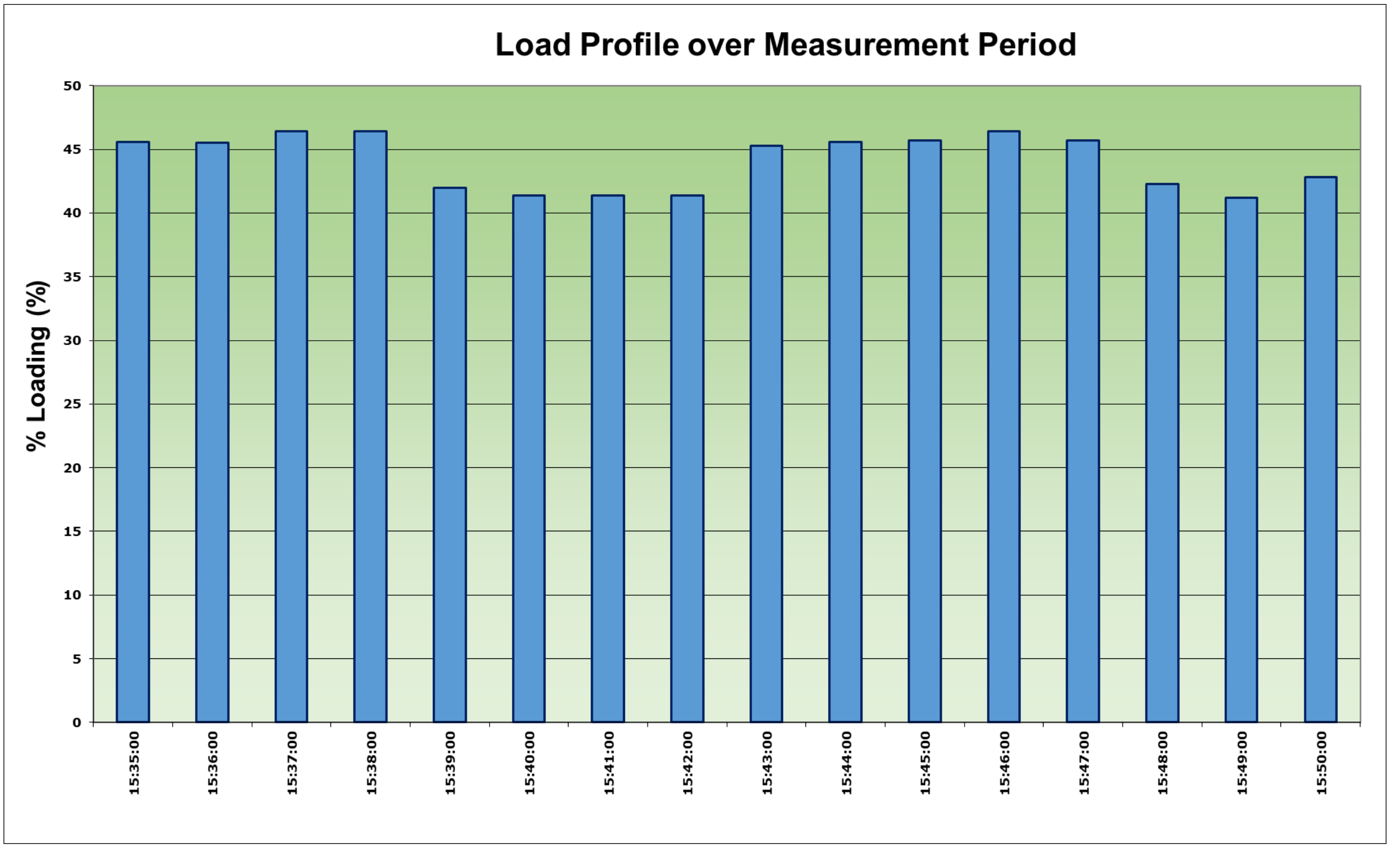

Loss Reduction with Powersmiths
Losses (kW)
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
Replaced
11:44:00
11:45:00
11:46:00
11:47:00
11:48:00
11:49:00
11:50:00
11:51:00
11:52:00
11:53:00
11:54:00
11:55:00
11:56:00
11:57:00
11:58:00
11:59:00
11:44:00
11:45:00
11:46:00
11:47:00
11:48:00
11:49:00
11:50:00
11:51:00
11:52:00
11:53:00
11:54:00
11:55:00
11:56:00
11:57:00
11:58:00
11:59:00
Baseline Vs Powersmiths Measurement Data

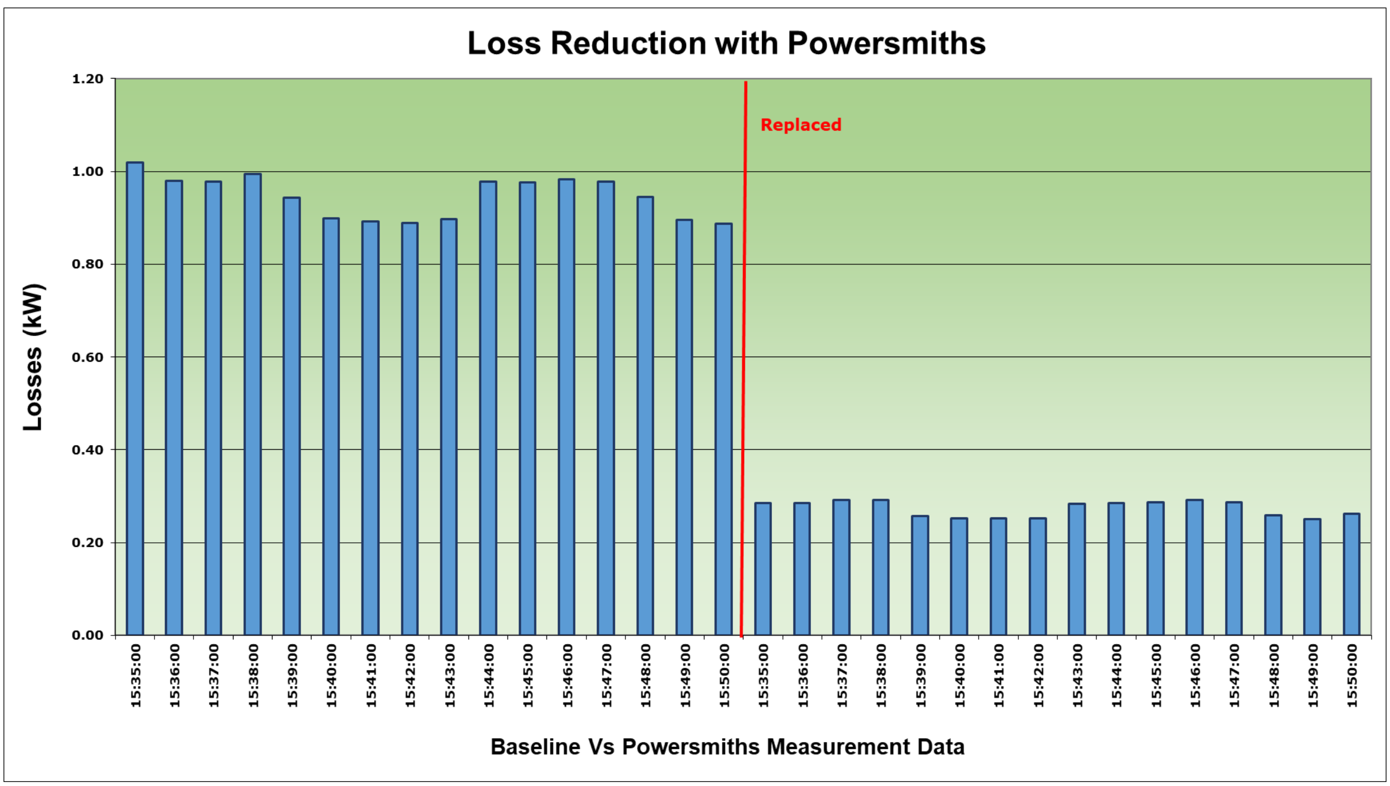
Transformer Measurement Table		
Building	Kahului WWTP	
Location	Dewatering Bldg Upstairs	
Tag Number	56237	
kVA	45	
	Baseline	Powersmiths
Measurement Period (HH:MM)	00:15	ISO 17025 Certified Test Lab
Sample Interval	1 Minute	
Manufacturer	Hevi-Duty	Powersmiths
Model	ET2H25S	E-Saver 2016
% Loading – Average	3.2%	4.3%
Losses (kW) – Average	0.631	0.100
Reduction in Average Losses		84.1%


Load Profile over Measurement Period
% Loading (%)
8
7
6
5
4
3
2
1
0
12:49:00
12:50:00
12:51:00
12:52:00
12:53:00
12:54:00
12:55:00
12:56:00
12:57:00
12:58:00
12:59:00
13:00:00
13:01:00
13:02:00
13:03:00


Loss Reduction with Powersmiths
Losses (kW)
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Replaced
12:49:00
12:50:00
12:51:00
12:52:00
12:53:00
12:54:00
12:55:00
12:56:00
12:57:00
12:58:00
12:59:00
13:00:00
13:01:00
13:02:00
13:03:00
12:49:00
12:50:00
12:51:00
12:52:00
12:53:00
12:54:00
12:55:00
12:56:00
12:57:00
12:58:00
12:59:00
13:00:00
13:01:00
13:02:00
13:03:00
Baseline Vs Powersmiths Measurement Data

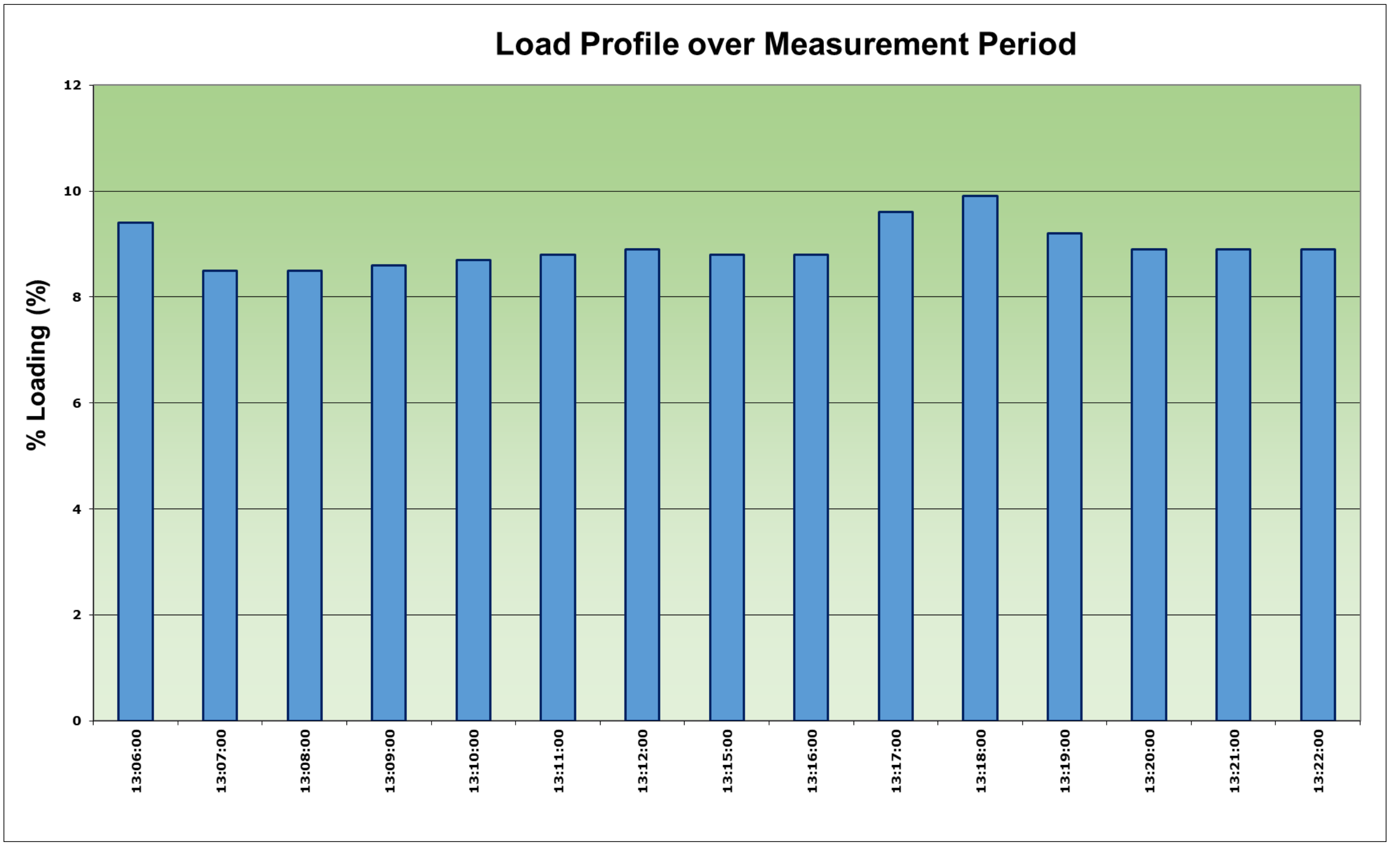
Transformer Measurement Table		
Building	Kalana O Maui Building	
Location	Basement Main Electric Room	
Tag Number	56242	
kVA	45	
	Baseline	Powersmiths
Measurement Period (HH:MM)	00:16	ISO 17025 Certified Test Lab
Sample Interval	1 Minute	
Manufacturer	Hevi-Duty	Powersmiths
Model	T2H45	E-Saver 25H
% Loading – Average	44.1%	44.2%
Losses (kW) – Average	0.946	0.273
Reduction in Average Losses		71.1%

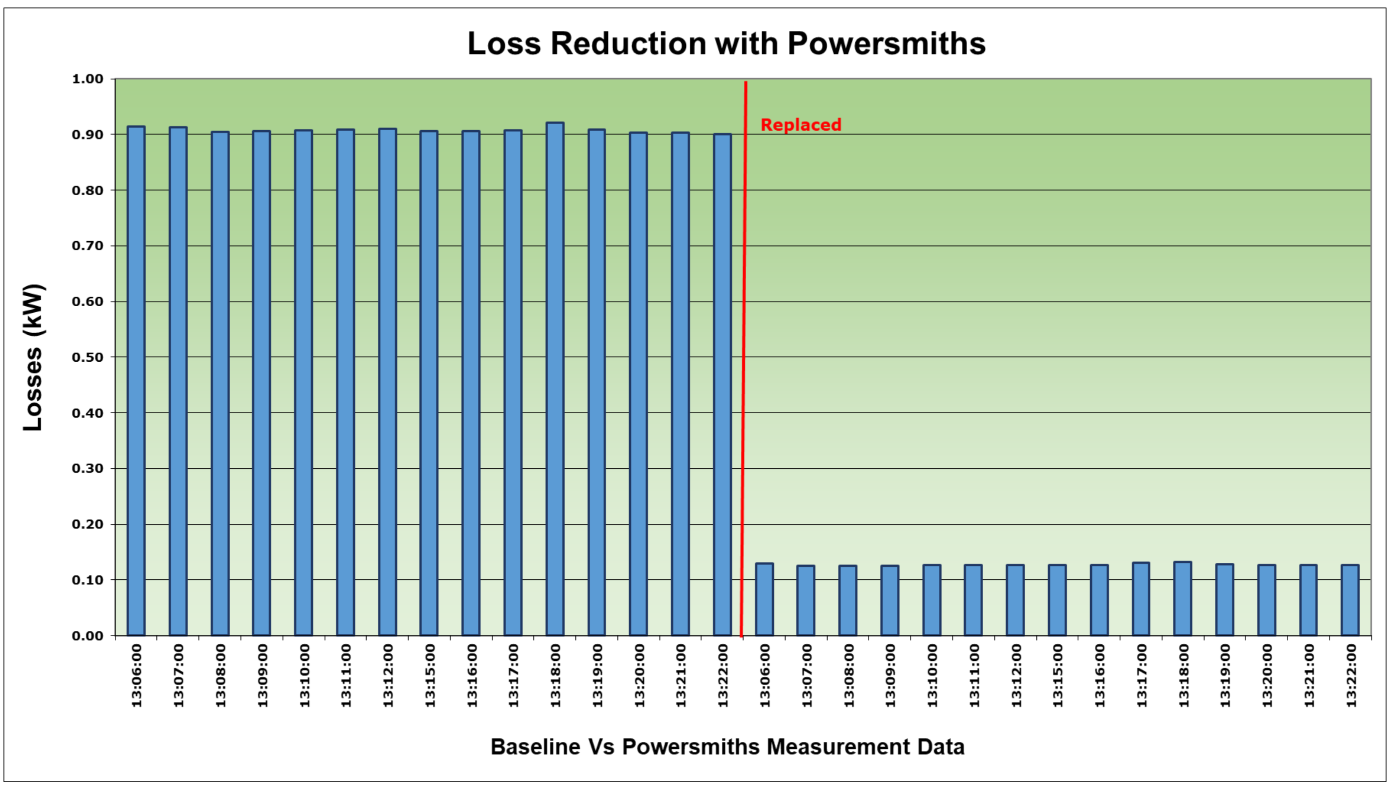

Load Profile over Measurement Period
% Loading (%)
50
45
40
35
30
25
20
15
10
5
0
15:35:00
15:36:00
15:37:00
15:38:00
15:39:00
15:40:00
15:41:00
15:42:00
15:43:00
15:44:00
15:45:00
15:46:00
15:47:00
15:48:00
15:49:00
15:50:00


Loss Reduction with Powersmiths
Losses (kW)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Replaced
15:35:00
15:36:00
15:37:00
15:38:00
15:39:00
15:40:00
15:41:00
15:42:00
15:43:00
15:44:00
15:45:00
15:46:00
15:47:00
15:48:00
15:49:00
15:50:00
15:35:00
15:36:00
15:37:00
15:38:00
15:39:00
15:40:00
15:41:00
15:42:00
15:43:00
15:44:00
15:45:00
15:46:00
15:47:00
15:48:00
15:49:00
15:50:00
Baseline Vs Powersmiths Measurement Data

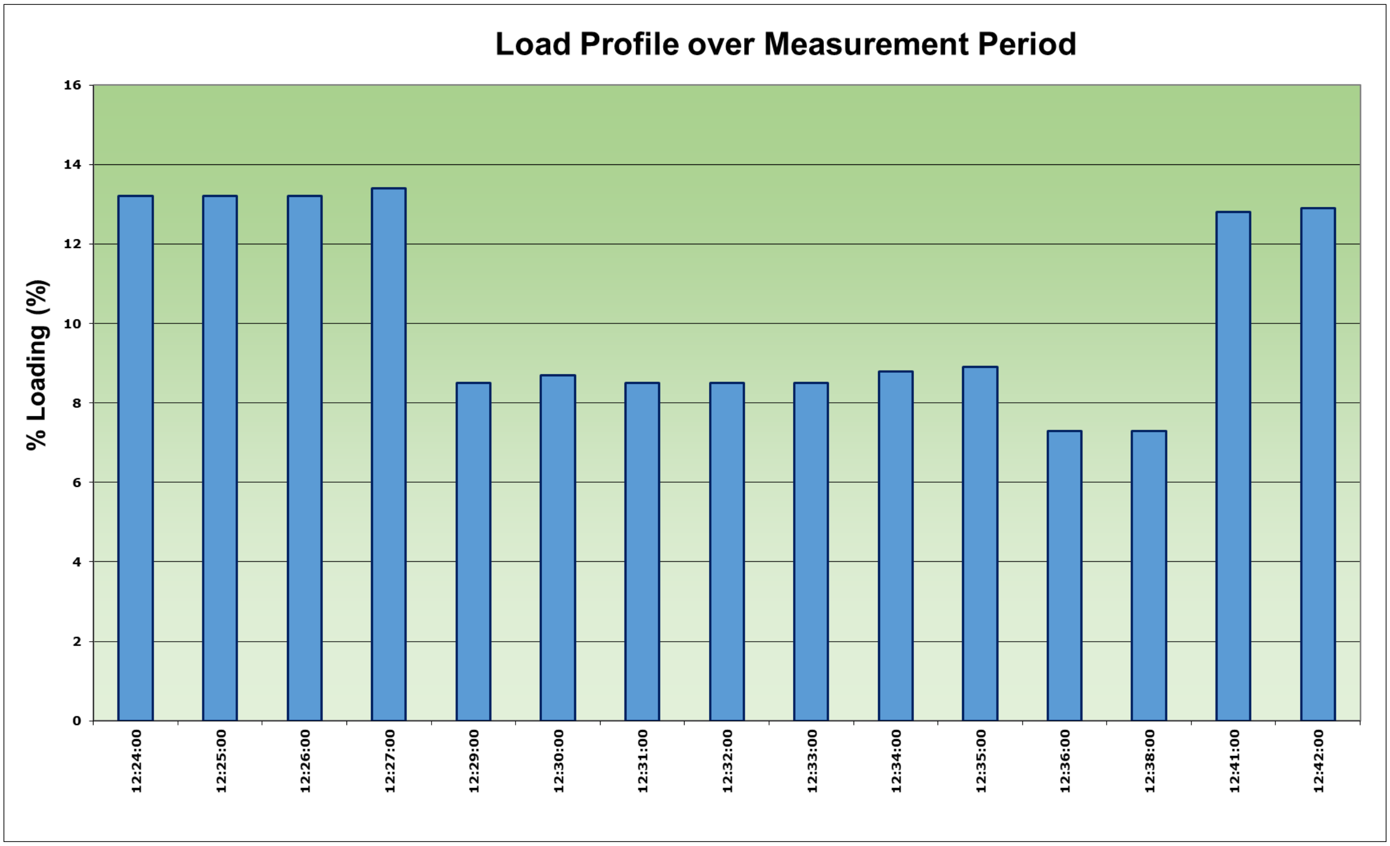
 

Transformer Measurement Table		
Building	Kahului Baseyard	
Location	Telemetry Bldg Elec Room	
Tag Number	56216	
kVA	75	
	Baseline	Powersmiths
Measurement Period (HH:MM)	00:15	ISO 17025 Certified Test Lab
Sample Interval	1 Minute	
Manufacturer	Hevi-Duty	Powersmiths
Model	T2HB75	E-Saver 80R
% Loading – Average	9.0%	9.0%
Losses (kW) – Average	0.908	0.128
Reduction in Average Losses		85.9%


Load Profile over Measurement Period
% Loading (%)
12
10
8
6
4
2
0
13:06:00
13:07:00
13:08:00
13:09:00
13:10:00
13:11:00
13:12:00
13:15:00
13:16:00
13:17:00
13:18:00
13:19:00
13:20:00
13:21:00
13:22:00


Loss Reduction with Powersmiths
Losses (kW)
Replaced
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
13:06:00
13:07:00
13:08:00
13:09:00
13:10:00
13:11:00
13:12:00
13:15:00
13:16:00
13:17:00
13:18:00
13:19:00
13:20:00
13:21:00
13:22:00
13:06:00
13:07:00
13:08:00
13:09:00
13:10:00
13:11:00
13:12:00
13:15:00
13:16:00
13:17:00
13:18:00
13:19:00
13:20:00
13:21:00
13:22:00
Baseline Vs Powersmiths Measurement Data

Transformer Measurement Table		
Building	**Kihei WWTP**	
Location	**Elec Shop Weight Room**	
Tag Number	**56232**	
kVA	**75**	
	Baseline	**Powersmiths**
Measurement Period (HH:MM)	**00:15**	**ISO 17025 Certified Test Lab**
Sample Interval	**1 Minute**	
Manufacturer	**Square D**	**Powersmiths**
Model	**75T3H**	**E-Saver 80R**
% Loading – Average	**10.2%**	**11.1%**
Losses (kW) – Average	**0.902**	**0.131**
Reduction in Average Losses		**85.4%**


Load Profile over Measurement Period
% Loading (%)
16
14
12
10
8
6
4
2
0
12:24:00
12:25:00
12:26:00
12:27:00
12:29:00
12:30:00
12:31:00
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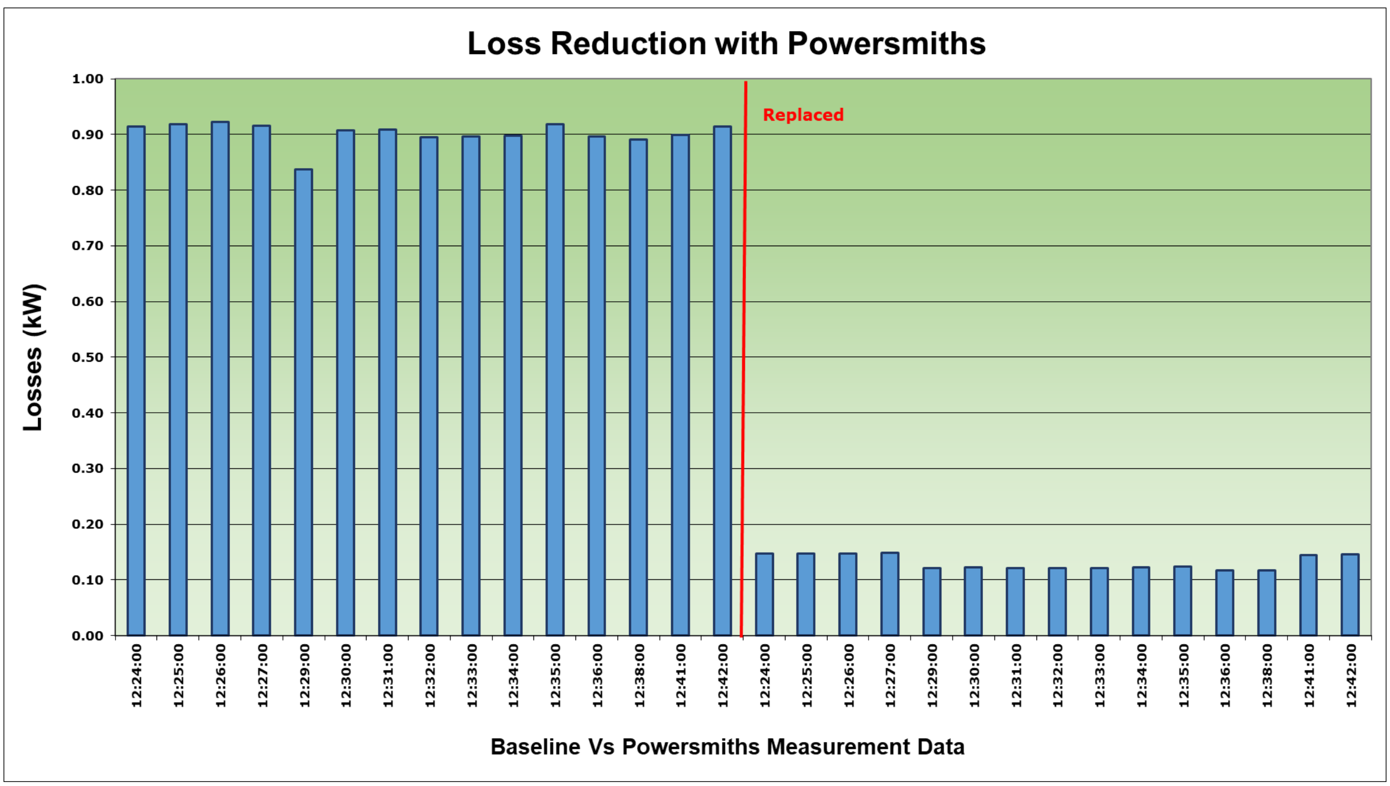
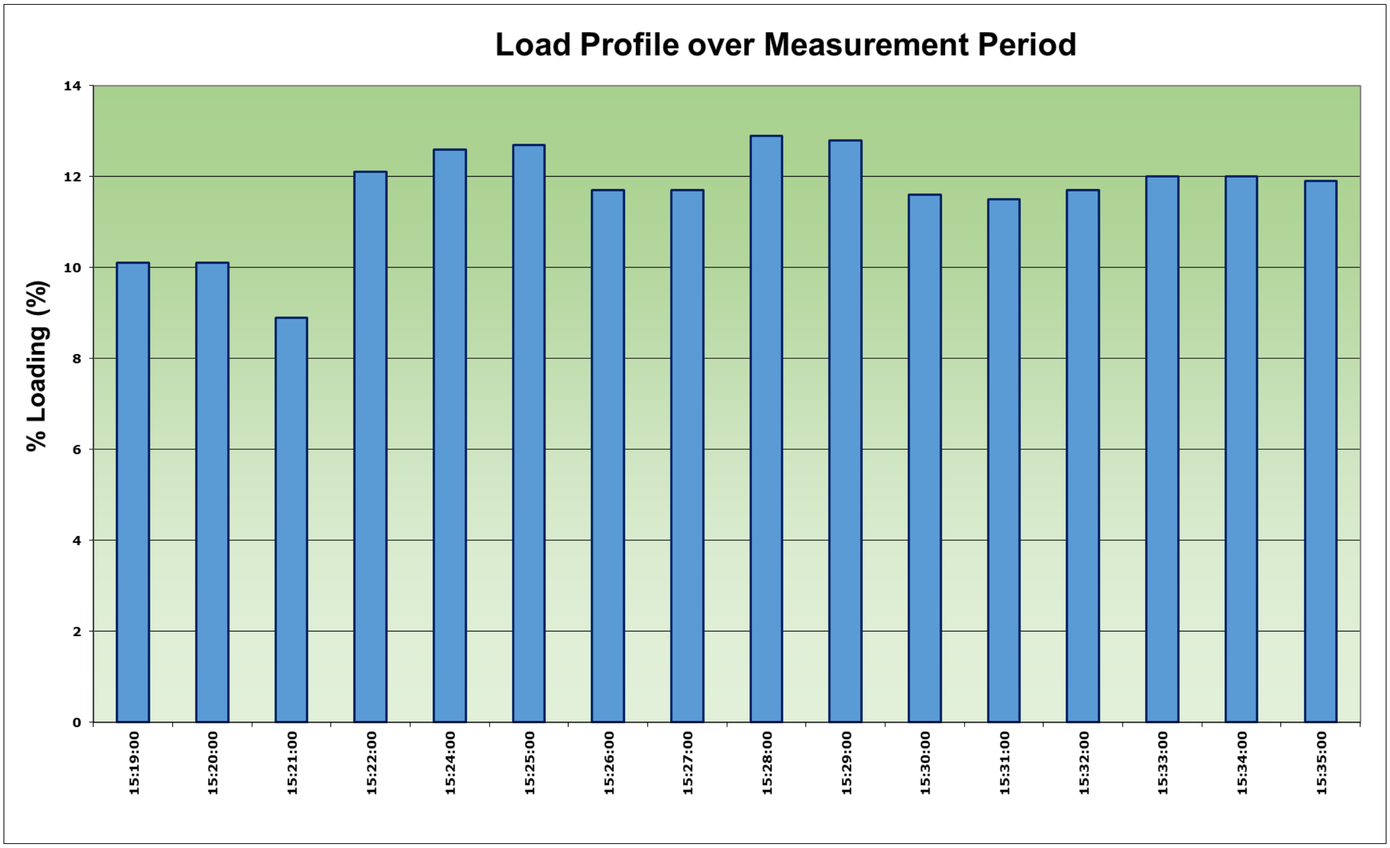
12:35:00
12:36:00
12:38:00
12:41:00
12:42:00


Loss Reduction with Powersmiths
Losses (kW)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Replaced
12:24:00
12:25:00
12:26:00
12:27:00
12:29:00
12:30:00
12:31:00
12:32:00
12:33:00
12:34:00
12:35:00
12:36:00
12:38:00
12:41:00
12:42:00
12:24:00
12:25:00
12:26:00
12:27:00
12:29:00
12:30:00
12:31:00
12:32:00
12:33:00
12:34:00
12:35:00
12:36:00
12:38:00
12:41:00
12:42:00
Baseline Vs Powersmiths Measurement Data

Transformer Measurement Table		
Building	Lahainaluna WTP	
Location	Main Electric Room	
Tag Number	56258	
kVA	75	
	Baseline	Powersmiths
Measurement Period (HH:MM)	00:16	ISO 17025 Certified Test Lab
Sample Interval	1 Minute	
Manufacturer	Hevi-Duty	Powersmiths
Model	T2H75S	E-Saver 80R
% Loading – Average	11.6%	11.9%
Losses (kW) – Average	0.923	0.139
Reduction in Average Losses		84.9%


Load Profile over Measurement Period
% Loading (%)
14
12
10
8
6
4
2
0
15:19:00
15:20:00
15:21:00
15:22:00
15:24:00
15:25:00
15:26:00
15:27:00
15:28:00
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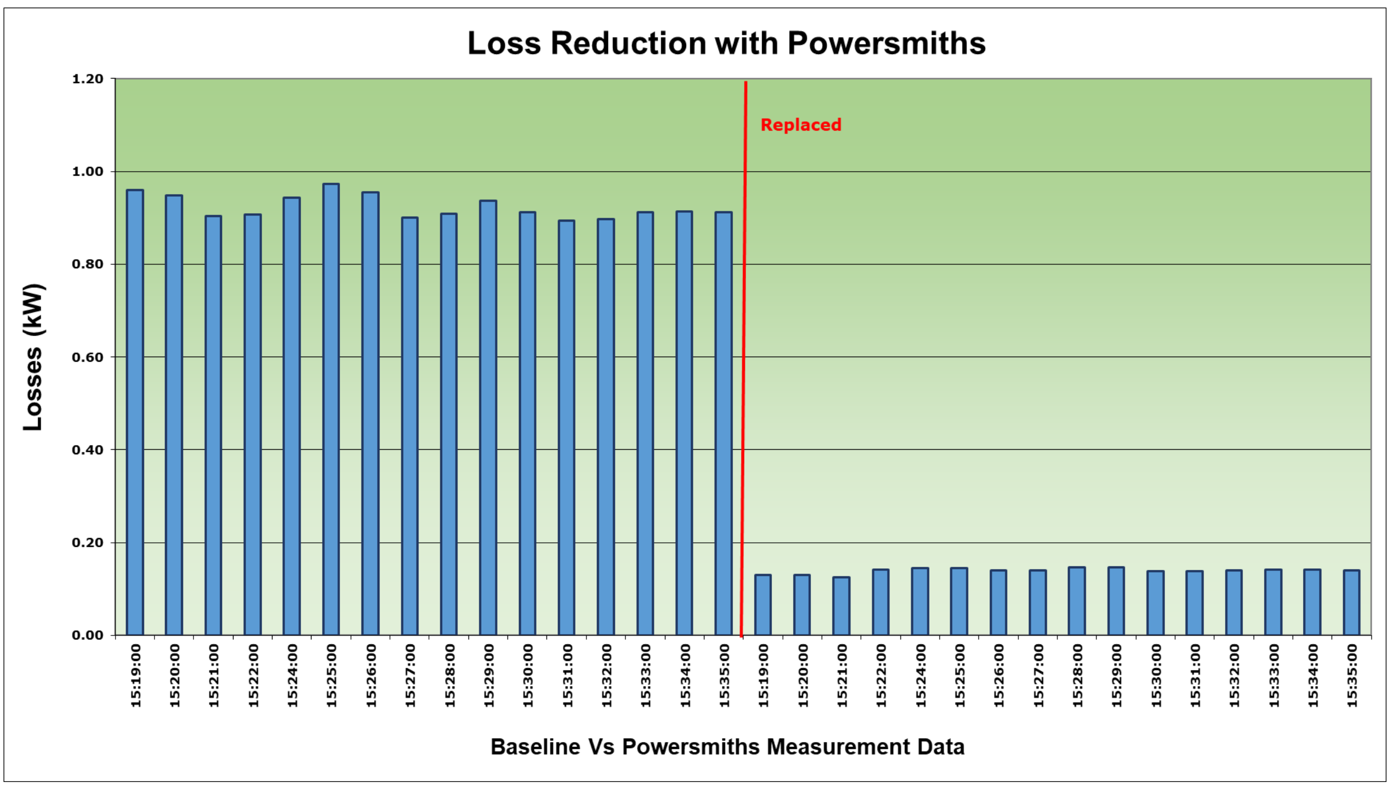
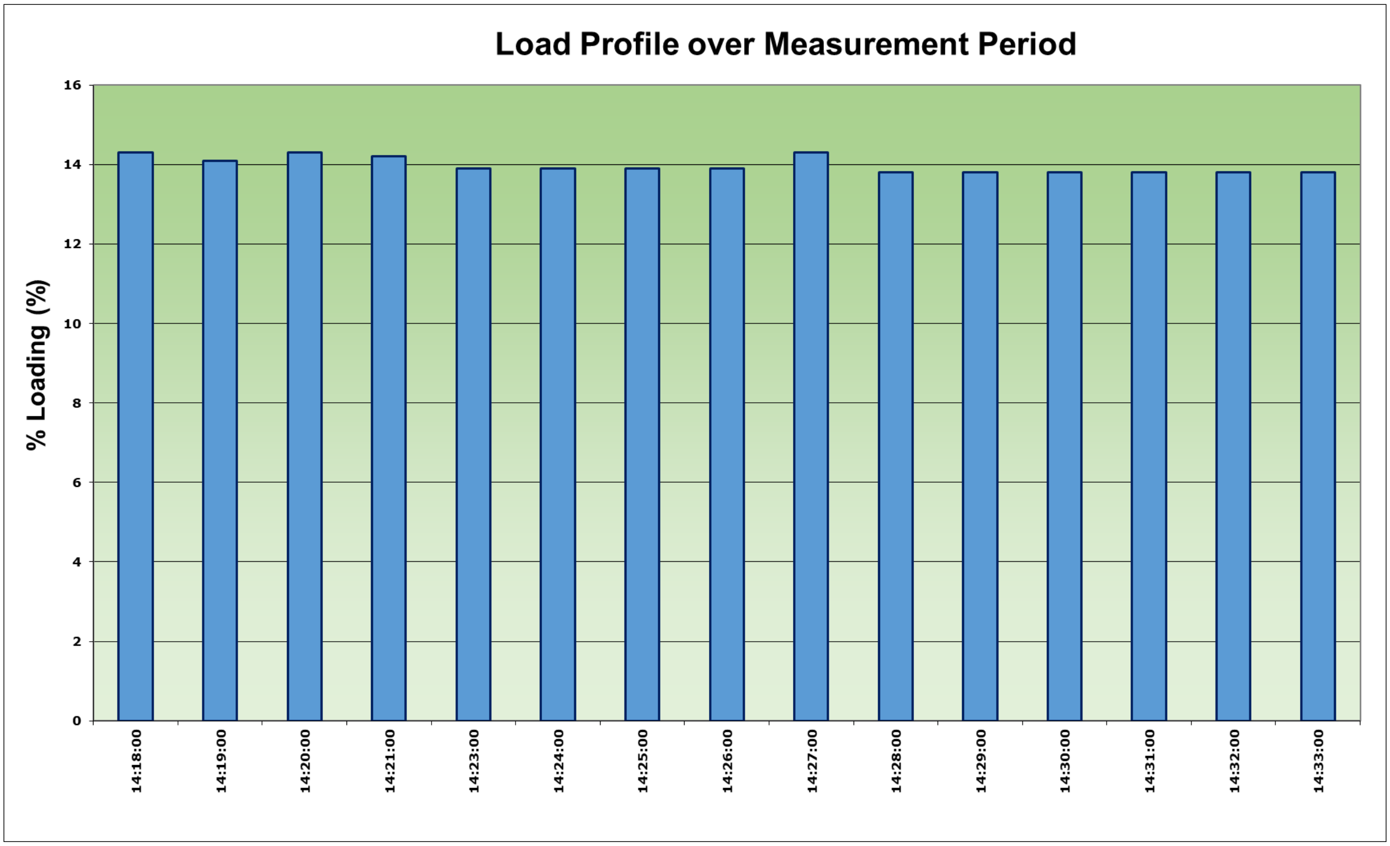
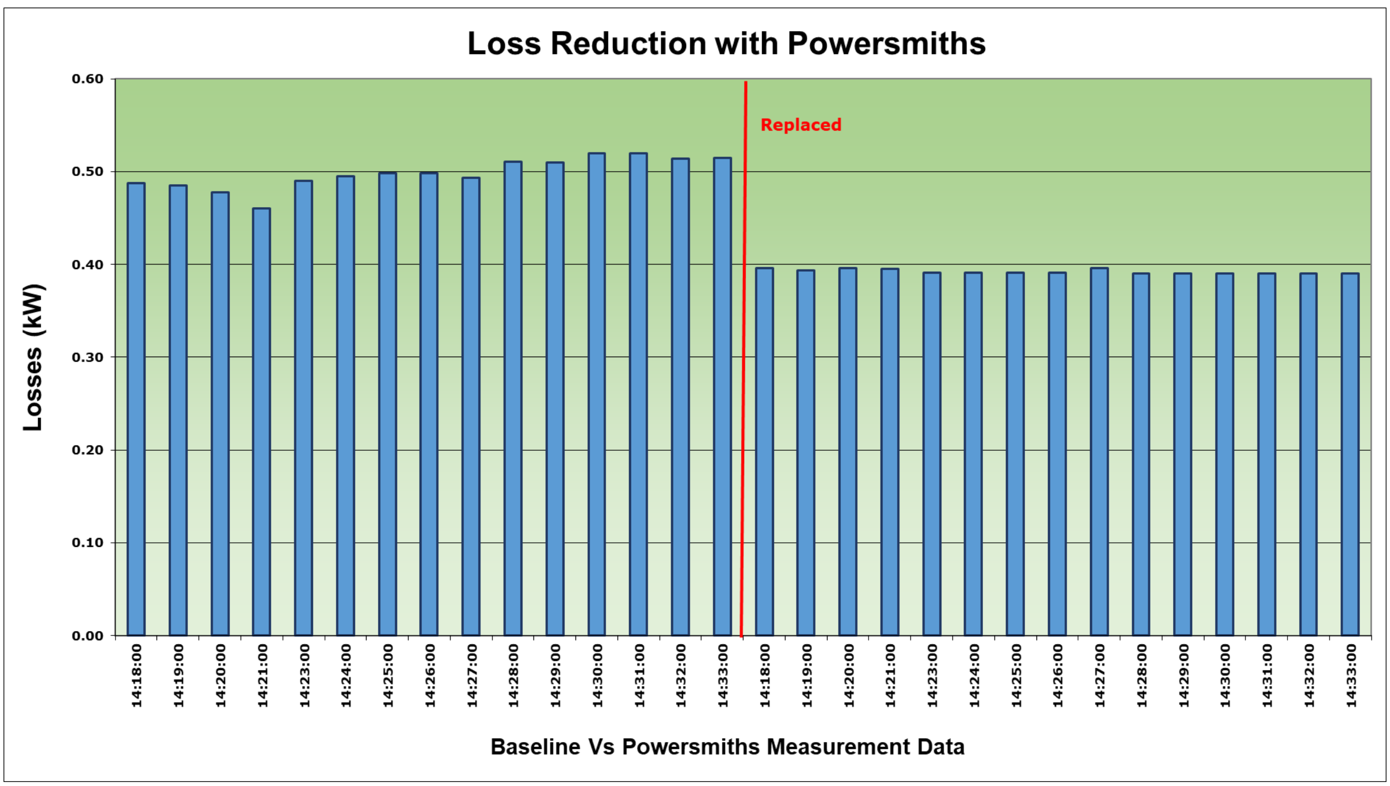
15:31:00
15:32:00
15:33:00
15:34:00
15:35:00


Loss Reduction with Powersmiths
Losses (kW)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
Replaced
15:19:00
15:20:00
15:21:00
15:22:00
15:24:00
15:25:00
15:26:00
15:27:00
15:28:00
15:29:00
15:30:00
15:31:00
15:32:00
15:33:00
15:34:00
15:35:00
15:19:00
15:20:00
15:21:00
15:22:00
15:24:00
15:25:00
15:26:00
15:27:00
15:28:00
15:29:00
15:30:00
15:31:00
15:32:00
15:33:00
15:34:00
15:35:00
Baseline Vs Powersmiths Measurement Data

Transformer Measurement Table		
Building	Kihei Police Station	
Location	Main Electric Room	
Tag Number	56222	
kVA	225	
	Baseline	Powersmiths
Measurement Period (HH:MM)	00:15	ISO 17025 Certified Test Lab
Sample Interval	1 Minute	
Manufacturer	Eaton	Powersmiths
Model	V48M28T22EEUS	E-Saver 80R
% Loading – Average	14.0%	14.0%
Losses (kW) – Average	0.498	0.392
Reduction in Average Losses		21.3%


Load Profile over Measurement Period
% Loading (%)
16
14
12
10
8
6
4
2
0
14:18:00
14:19:00
14:20:00
14:21:00
14:23:00
14:24:00
14:25:00
14:26:00
14:27:00
14:28:00
14:29:00
14:30:00
14:31:00
14:32:00
14:33:00


Loss Reduction with Powersmiths
Losses (kW)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
Replaced
14:18:00
14:19:00
14:20:00
14:21:00
14:23:00
14:24:00
14:25:00
14:26:00
14:27:00
14:28:00
14:29:00
14:30:00
14:31:00
14:32:00
14:33:00
14:18:00
14:19:00
14:20:00
14:21:00
14:23:00
14:24:00
14:25:00
14:26:00
14:27:00
14:28:00
14:29:00
14:30:00
14:31:00
14:32:00
14:33:00
Baseline Vs Powersmiths Measurement Data

Powersmiths E-Saver Transformer Benefits

The E-Saver transformer is the ideal transformer for environments where energy savings are a priority. The E-Saver is a practical and affordable solution for buildings where lowest life-cycle cost and energy savings are a priority.

Characteristics
The E-Saver sets new benchmarks for environmental protection, loss reduction and reliability. Designed to provide the lowest life cycle cost, the E-Saver goes beyond US DOE 2016 efficiency ensuring lower operating losses than standard off-the-shelf transformers. To provide superior performance and reduce environmental impact, the E-Saver comes with a superior Nomex based insulation system impregnated with an organic epoxy adhesive.

Customization
E-Saver transformers are designed and manufactured to fit within the existing footprint or constraints and are provided with custom lug termination configurations. Custom design and manufacturing allows for faster installation and lower installation costs.

Quiet Operation
Working or learning environments can be degraded or disrupted when noisy transformers are located close to people. To meet this challenge, the E-Saver has embedded structural and acoustic treatments that combine to reduce ambient noise generated by the transformer. To ensure quiet operation, noise tests are part of our ISO 9001 procedures for every transformer.

Environmental
The E-Saver is built in an ISO 9001 (quality management) and ISO 14001 (environmental management) certified facility. Throughout the manufacturing process, Powersmiths takes steps to ensure that waste is eliminated and hazardous materials are avoided. Because Powersmiths transformers generate lower losses, they reduce power drawn from generating stations resulting in less smog and lower greenhouse gas emissions.

Testing
E-Saver transformers are subjected to rigorous testing to ensure superior performance under various load profiles and loading conditions, quiet operation, and insulation integrity and production tests with actual computer power loading. Powersmiths' test facility has been certified to ISO 17025 for efficiency testing by Canadian Standards Association International (CSA).

Warranty
The E-Saver's long life and dependable performance is backed up by Powersmiths' industry leading 32-year pro-rated warranty